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THE NEW POWER PLANT of the Manhattan Ry., generating electric current for operating the New York elevated railways, will have a normal capacity of 64,000 HP. (or 40,000 K-W.), with a maximum capacity of nearly 100,000 HP. (or 62,500 K-W.). The plant will consist of eight compound engines, rated at 8,000 HP. each under the most economical load, but capable of operating continuously under a load of 12,000 HP. The engines are arranged in pairs, each pair driving a shaft on which is a Westinghouse generator, with a revolving field 32 ft. in diameter, weighing about 185 tons. The speed is about 75 revolutions per minute. Current is generated at 11,000 volts and converted at seven sub-stations by step-down transformers to 625 volts, which is the current delivered to the third rail. The engines are the most powerful ever built for electric railway service. They are of a novel type, having the high-pressure cylinders horizontal and the low-pressure cylinders vertical. This arrangement has quite recently, however, been used for some large blowing engines. With this arrangement, and with two engines to each shaft, the turning movement is so well distributed that no flywheel is required, the revolving field of the generator being sufficient to act in that capacity. The high-pressure cylinders are 44 × 88 ins., and the low-pressure cylinders are 60 × 88 ins.; the engines are fitted with the Reynolds-Corliss valve gear. These engines are being built by the Edward P. Allis Co., of Milwaukee, Wis., to special designs prepared by Mr. Edwin Reynolds, M. Am. Soc. M. E., Vice-President of that company.

A $3,000,000 ORDER for electric train equipment has been placed with the General Electric Co. by the Manhattan Railway Co., of New York city. This company owns all the elevated roads on Manhattan Island and has hitherto used steam locomotives exclusively. In the new equipment the multiple unit system of train control will be used and 800 motor cars and 400 trailer cars will be provided. In the General Electric system of train control the motor circuits on the several motor cars are opened and closed by magnets operated by a train circuit carrying a comparatively small current.

THE 140-MILE ELECTRIC TRANSMISSION LINE from the Yuba River to Oakland, Cal., has been put into successful operation. The current is transmitted at 40,000 volts, which will probably be increased to 50,000 or 60,000 volts. Preparations are being made to transmit power to San Jose, a distance of 190 miles from the generating plant.

A SYSTEM OF ELECTRIC TRACTION of a very remarkable character is being tried in Belgium, according to the London "Electrician." Assume the field or stator of an induction motor to be developed along a straight line and the rotor to be developed in the same way. A magnetic field may be caused to move along the line, and the squirrel-cage rotor, having become a ladder with copper rungs and sides, will tend to travel along with the moving field. This ideal system of traction, in which no contact is necessary between the train and the electric line is being seriously experimented with by MM. Rosenfeld and Zelaney, assisted by M. Julien Dulait, who is head of the firm Electricité et Hydraulique. A mile of experimental track is being laid and a concession for about 10 miles on the State railways has been promised by the Belgian Government. It is particularly intended to develop the system for high-speed railways, such as the proposed line between Brussels and Antwerp. In the form the system has taken up to the present the car runs on an ordinary standard track, but between the rails is a second pair of rails at a slightly higher level upon which runs the small locomotive, which is connected to the car by a chain and runs underneath it between the wheels. The auxiliary track is of about 28-in. gage, and between its rails are rectangular stators 32 ft. long and 130 ft. apart. An air-gap of less than ½-in. is employed and it is calculated that with a 150-K-W. stator an efficiency of 84 to 87% can be obtained, providing the speed is 60 to 78 miles per hour. The generating station supplies three-phase current at 15,000 volts, which is transformed down to 5,000 volts, at which pressure it is distributed to the stators. The line is divided into 1,600-ft. sections, and as the car passes on to each section it completes the circuit of a low-pressure current supplied from the sub-stations and thereby actuates a switching gear so that only the section on which the car is traveling is supplied with current.

THE CANADIAN-NIAGARA POWER CO., financed and managed by the Niagara Falls Power Co., will at once begin work on a power tunnel on the Canadian side. The company proposes to develop 35,000 HP., and expects to sell most of this to local users and to transmit 10,000 HP. to Toronto. The inlet canal will start at the head of Clear Island, leading to the power house in Victoria Park, where a wheel-pit will be built having a capacity of 100,000 HP. A tail-race tunnel will carry the water from the turbines to the river below the Horseshoe Falls. The contractor for the work is A. C. Douglas, who built the wheel-pit on the American side. By an agreement with the Commissioners of Victoria Park, the company has until July 1, 1903, to have 10,000 HP. developed ready for use, and water connections made for 25,000 HP. The Commissioners of the park agree not to compete in the developement of power; unless the failure of the other party compels them to take over the plant.

SEVERAL CHANGES IN THE RAPID TRANSIT RAILway were decided upon at the last meeting of the Rapid Transit Commission. According to these decisions, there will be a tunnel under the Harlem River into the Bronx, and not an elevated structure. Besides the great bridge station at the beginning of the City Hall loop, there is to be built a second station on the loop just opposite the City Hall at the junction of Mail St. and the park. Instead of having three tracks only at the stations as far north as 145th St., Contractor McDonald will also provide for them at the 157th St. station, and instead of having his great west side storage yards at 103d and 116th Sts., he will have them at 137th and 145th Sts. Originally it had been planned to have the four tracks of the main line end at a point between 103d and 104th Sts. From there the two branches, one to the east and the other to the northwest, were to deviate. At the stations at 103d and 116th Sts. were to be large storage yards. Along the inter-station parts of the west side branch there were, and are still, to be only two tracks, but alongside the stations at 116th, 137th and 145th Sts. were to be such arrangements of sidings as to make three tracks at those points, so that express trains might dart past local ones without using the same rails just at the stations. The new plan that has been adopted provides that a similar arrangement of sidings shall be made at the 157th St. station, making it as much of an express station as any of those below it.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Thayer, Ia., on the Chicago, Burlington & Quincy Ry. on May 6. A passenger train running at 70 miles per hour collided with a freight train which was backing into a siding. The engineman of the passenger train was killed and 30 passengers were hurt.

THE CITY OF JACKSONVILLE, FLA., was swept by a disastrous fire on May 3, which destroyed 130 blocks of the city, rendering 10,000 people homeless and consuming property valued at $10,000,000 to $15,000,000. Many of the finest public and private buildings were destroyed, including hotels, theatres, churches and residences.

THE AMERICAN LINER "NEW YORK," which was disabled by the breaking of her port shaft and the explosion of an ammonia machine on March 15, was again disabled at sea by the breaking of the port shaft on April 22. The vessel will now be sent to Cramps' shipyard at Philadelphia to be re-engined. This is the fourth accident of this sort which has happened to the "New York" within a year.

SEWAGE PURIFICATION, as the only escape from loss by legal damages, is illustrated in a case lately decided in England. The Willcocks and the Hamlyn Brothers were both mill owners near the River Dart. The defendants owned a mill on the upper stream, and, having been forbidden by the local authorities further to pollute the stream, they turned the effluent sewage of 300 or 400 houses into an existing sewerage system and thus diminished the flow in the river. The plaintiffs owned two paper mills down stream, one in operation for 100 years, and they sued because of diminished stream flow and a compulsory resort to artificial power to obtain sufficient water. The defendants urged that by repairing the Stocker Brook "leat" they had added to the stream an amount equal to that abstracted, and further urged that they were ordered to take this water from the stream by the sanitary authorities, under penalty of proceedings under the River Pollution Act. Mr. Justice Day decided that the case was one for substantial damages, and that the authorities had very properly demanded that the water should not be returned to the Dart in a polluted state. Under these two fires, the only course left for the defendant was the purification of the sewage before allowing it to enter the river.

THE PANAMA CANAL CO., through President Hutin, has made a proposition to the U. S. State Department, through the Colombian Minister, to sell its property to the United States. It proposes that the United States and the canal company each appoint an appraiser; and if they are unable to agree on a price, to select an arbitrator whose decision shall be final. This proposition may be referred to the Isthmian Canal Commission, which has insisted upon an absolute surrender of the property as a first condition to treat with the Panama Canal Co.

AN ADRIATIC-BALTIC WATER ROUTE is projected by the Hungarian Ministry of Commerce, says U. S. Consul F. W. Mahin, of Reichenberg. The route proposed contemplates the joining of the Oder and the Danube by a canal. It would start at Fiume, a Croatian seaport on the Adriatic; go up the River Kulpa and down the Save; then by an existing canal to the Danube; up the Danube to the Province of Moravia, where a canal would be built to the Oder through a connecting valley; and then down the Oder River to Stettin, a German seaport on the Baltic.

A SEWERAGE SYSTEM FOR BALTIMORE, MD., has been authorized by a special session of the state legislature. To become effective it must be approved by popular vote. It is understood that an election will be held in May; also that the system will cost about $12,000,000.

A SITE FOR A SLOW-SAND FILTRATION PLANT for Washington, D. C., has been selected by a board of army engineers, recommended by Gen. John M. Wilson, Chief of Engineers, U. S. A., and approved by Secretary Root. The site is east of the new reservoir, between the Soldiers' Home and North Capitol St.

A CIVIL SERVICE EXAMINATION for the position of electrical and mechanical expert in the Bureau of Yards and Docks, U. S. Navy, will be held at the Navy Yard, Washington, D. C., on May 17. The pay of the position will be fixed at $7.04 or $6 per day, as the result of the examination may warrant. The examination will be open only to those who can give evidence of having received a degree in an electrical or mechanical course from an institution of learning in good standing, and who have since then had at least three years' experience in the design, manufacture or supervision during or after installation of electrical machinery, including the various types of dynamos and motors and modern methods of electrical distribution of power for industrial purposes, and of steam plants, including engines, boilers, piping, valves and all accessories, and who are familiar with the requirements and use of other machinery required for navy yard work, including centrifugal pumps, machinery operated by hydraulic power, machinery operated by pneumatic power, plants for heating and ventilation, central electric power and lighting plants, wiring, telephone systems, storage battery plants, etc. The examination will cover such theoretical knowledge as is essential to the proper understanding of the work which will be required to be performed by the successful applicant, and will include problems in electrical and mechanical work, testing the applicant's knowledge of mathematics, questions and problems relating to the design and construction of machinery and plants mentioned above, writing of specifications for same, practical knowledge of the testing of the above-mentioned plants and of the operation of same. Applications must be addressed to the Commandant, Navy Yard, Washington, D. C.

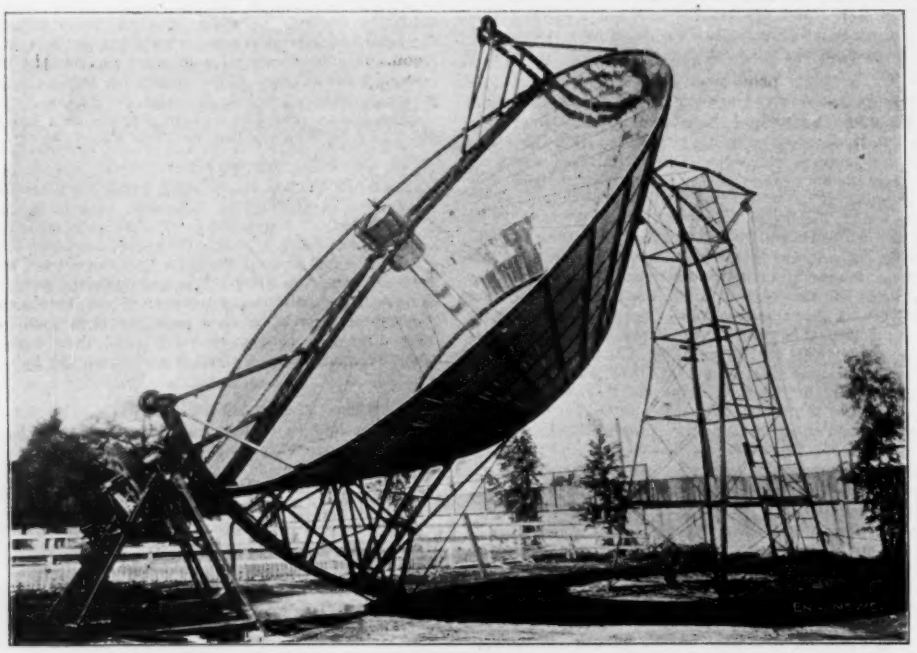
A CIVIL SERVICE EXAMINATION for the position of draftsman on bridge construction will be held at the rooms of the Municipal Civil Service Commission of New York city on May 17. The subjects of examination will be technical knowledge, experience, handwriting and mathematics. The technical paper will be mainly devoted to structural bridge work and designing.

THE ANTHRACITE COAL FIELDS OF PENNSYLvania and the annual production of each of the three separate fields since 1820 is shown in a large diagram and in tables recently issued by the U. S. Geological Survey and compiled by Wm. W. Ruley, Chief of the Bureau of Anthracite Coal Statistics, in Philadelphia. In the period 1820-1900, covered by the tables, the total annual shipments have increased from 365 tons to 45,107,484 tons, with a maximum of 46,511,477 tons in 1895. Of the three coal fields—Wyoming, Lehigh and Schuylkill regions—the percentage of shipments in 1900 were: 54.73, 15.33 and 29.94, respectively, in the order named above.

THE SOLAR MOTOR AT PASADENA, CAL.

By Alfred L. Davenport, A. M.

Considerable attention has been directed of late by the popular press to the performance of a new solar motor which has been erected at South Pasadena, Cal. The present machine is the result of a series of expensive experiments extending through several years. It was built in Boston, where the company controlling it is located, and was shipped to Pasadena some months ago to give the promoters the benefit of the perpetual sunshine of the Southern California summers in which to finish their work.



SOLAR MOTOR AT SOUTH PASADENA OSTRICH FARM, SOUTH PASADENA, CAL.

The present degree of perfection of the apparatus has been attained, not so much by any inventions, as by painstaking attention to all the details and the improved application of principles which have been made use of in former, unsuccessful solar motors.

The two principal features of the machine are the reflector and the boiler. The reflector takes the form of a truncated right circular cone. The greatest diameter is about 33 ft., the smallest diameter 16 ft. The surface of the reflector is made up of 1,788 plane mirrors whose reflecting sides form the inner surface of the cone. These mirrors are of glass, of the thickness of ordinary window glass, and are covered on the back with three coats of pure silver, and over this is a preparation to render them weather-proof.

It will be seen that if the axis of the cone is in line with the sun, all rays incident upon the mirrors will come to focus on the axis. The reflector is put in this position in the morning, and is automatically kept in focus by an escapement device which is operated electrically by a clock every twenty seconds. The reflector is thus put in perfect focus every twenty seconds throughout the day.

The whole machine is suspended in two trolley ways by two heavy cables. The rollers are pivoted on top of either tower, and the tracks are double and curved, so that the entire reflector may be revolved on the rollers to secure the proper declination. The photograph was taken in the winter, when the sun was far south, and shows the reflector tipped well up on edge.

The structural work is entirely of iron, and is designed to resist a wind velocity of 100 miles per hour.

The boiler is, of course, in the focus of the rays at the axis of the reflector. It is 13 ft. 6 ins. in length and has a capacity of 100 gallons of water, with an additional space of 8 cu. ft. for steam. The shell of the boiler is a large straight steel tube, with a steam dome at the upper end.

The interior construction of the boiler is of a special design, as is at once seen to be necessary, since it must be turned with the reflector through nearly 180° every day in order to follow the sun. A special device prevents water from siphoning over into the engine as the boiler is tipped back and forth. The managers do not wish to describe this feature of the apparatus at present. The boiler is, of course, furnished with a safety valve and water gage. It works at a pressure of 150 pounds, which is attained in one hour after the reflector is placed in focus. The boiler is covered with a preparation containing lamp-black.

A pipe covered with asbestos conducts the steam to the engine. The engine now used is of the compound condensing type, and of 11 HP.

The engine is belted to a centrifugal pump which raises 1,400 gallons per minute from an artificial well 16 ft. deep. The net lift appeared to be about 7 ft.

The most obvious application of solar power is to pump water from the thousands of wells which are used for irrigation in vast regions of Southern California, Nevada, New Mexico and Arizona. The days in those localities are almost absolutely cloudless from April to October, and the heat in many places is intense.

The chief obstacles to the development of large portions of these lands are scarcity of water and the high cost of fuel. If the solar motor succeeds in providing the former, while avoiding the cost of the latter, all the more desirable parts of the Great American Desert can be brought to a fair degree of productiveness.

It is thought that it will not be found advisable to increase the size of the machine over the one now in operation. This one now furnishes fully 10 HP., and improvements now under way will probably increase this to 15 HP.

Where large power is required several reflectors and boilers may be used to furnish steam to one large engine.

A COMPARISON BETWEEN AMERICAN A ND BRITISH ROLLING MILL PRACTICE.*

By Wm. Garrett,† M. Am. Soc. M. E.

The condition of the iron and steel trade in Great Britain to-day is attracting a great deal of attention. She who formerly held the supremacy in the manufacture of iron and steel has not only lost the same, but her shores are invaded by foreign material, in particular from the United States and Germany, who send there thousands of tons of raw and finished material, part of which is to be finished and part re-ported to foreign countries.

Great Britain is not only mistress of the [illegible] in time of war, but is also mistress of the se[illegible] time of peace. Her ships are found on [illegible] sea, at every shore, in every clime. Her [illegible] for reaching foreign countries are unequalled [illegible] any, and this, combined with her past wonde[illegible] resources in the way of fuel and iron ore, and [illegible] fact that she has been the home of a Cort, a [illegible] semer, a Mushet, a Siemens, a Thomas, a [illegible] crist and a Lowthian Bell—the achievement[illegible] every one of whom in their day and genera[illegible] has been an era in the manufacture of iron [illegible] steel—is what gave Great Britain the supremacy. First, the raw material; second, the market; and third, the brains. But in the course of time conditions have changed, and the fact that coal is being delivered in Newcastle, as it were, or material is being delivered at the door of those who at one time controlled the manufacture of this material, proves this to be the case.

This being so, what are the conditions that have changed? Lack of raw material? It appears not, for you are the second largest producers of coal in the world, in 1898 producing 220,085,303 tons; and both Sir Lowthian Bell and Mr. Chas. Kirchoff are trying to outdo each other in proving that pig iron—the base of iron and steel—can be manufactured in Great Britain as cheaply as anywhere in the United States, taking into consideration the long haul necessary to bring the raw material together in the United States. Sir Lowthian Bell is very skeptical as to the possibility of any foreign country being able to land iron or steel on British shores in competition with Great Britain, believing the many thousands of miles iron and steel have to be transported is a barrier never to be overcome.

Is it because Great Britain is no longer mistress of the seas, and her foreign markets are not so accessible as in the past? No one for a moment believes that there ever was a time when she was better able to reach any part of the world than at the present time, and new markets are being opened up every day. What does the trouble in China and the Transvaal war mean? In the end more markets, not only for British products but for the products of the whole manufacturing world. This comes about through your "open-door" policy; and if it were not a political question, it might be admissible to dwell on this as the one reason why you are losing your supremacy in the manufacture of iron and steel.

It is not because you cannot make your pig iron as cheaply as it is made elsewhere. It is not because of the curtailment of your markets. It cannot be because of your ignorance of scientific truths—Sir Lowthian Bell points with pride to your scientific colleges at Newcastle, Leeds, Nottingham, Sheffield, Edinburgh and Glasgow for teaching the science of metallurgy. What then can be the reason why you are underbid on rail contracts in foreign countries? Why are tin plate bars being shipped by thousands of tons right into your tin plate district? Why are thousands of tons of soft steel billets being delivered to your rod mills and merchant mills, and thousands of tons of plates dumped right at the back door of many of your steel plate makers, while skelp and strips for the purpose of making pipe and tube are landed next door to your manufacturers of strips. It would seem that all the blame lies with the men who start with the pig iron and put it into the finished material.

But before going into this question just think for a moment what it means for the Pittsburg manufacturer to deliver his product in England or Scotland. It means that they have to ship their material over 3,000 miles by water and nearly 500 miles by land, at a cost of between $5 and $6 per ton. If everything were equal in the cost of manufacture in both countries, it means that the Pittsburg manufacturer should get his ore and coke for nothing in order to be able to do this. Evidently, then, the advantage of the manufacturer in the United States is not due wholly to cheaper raw material. To come to the point, then, where does this difference in the cost of manufacture come in, assuming that we are already agreed—which we have on the best of authority—that Great Britain can produce pig iron as cheaply as the United States? During the period

*A paper read at the annual meeting of the Iron and Steel Institute, held in London, May 9.

†Manager Garrett-Cromwell Engineering Co., Cleveland, O.

from 1893 to 1896, many thousands of tons of Bessemer pig iron were sold for $9, and 4-in. billets could be bought in the open market at that time for $14 per ton, a difference of $5 per ton. This proves that you are able to convert pig iron to steel billets for less than that amount, for some steel makers during that time paid a dividend. If not, then there is something wrong with your method of making Bessemer steel ingots and rolling them into billets.

BLOOMING MILLS.

As my remarks are to be confined to rolling mill practice, I will begin my comparison with the blooming or cogging mill. I understand Great Britain to be the birthplace of the Ramsbottom reversing engines and reversing blooming mills. America, in its early work in making Bessemer steel, adopted the three-high system; and no two men have done more to perfect this system than Mr. John Fritz and his brother George; but since the advent of the 4-in. billet, which is now so universally used in the United States, the two-high reversing mills have become almost universal, except for rail mill purposes. We simply copied what you had already done, and improved upon it. The reason why a three-high mill is not considered as well adapted to make 4-in. billets is because when, as is often the case, a 6,000-lb. ingot is used, the piece would be over 125 ft. long when finished to a 4-in. billet, and the lifting tables would have to be very long, in fact, too long to be conveniently handled. Thus, with the exception of one or two mills which make some other product than billets, all 4-in. billets are made on two-high reversing mills.

Logically, no other country should have been before Great Britain in adopting the 4-in. billet as the standard size, yet the fact is that no country is more prejudiced against it. The reason for this is that all of your blooming mills are attached to finishing mills, upon which you make rails, structural shapes, large merchant bars and small billets. Owing to this diversity of product from one mill, there is necessarily a great deal of roll changing; and when changing rolls, the whole system is stopped from the ingot onward—everything standing still, time lost, money lost, and plant non-productive. In some places duplicate finishing mills are used in order to prevent this loss.

If your cogging mills were adapted to make 4-in. billets, the same as in the United States, and your small merchant mills and rod mills were adapted to take a 4-in. billet, all this loss would be obviated and the expense for an extra mill would be unnecessary, as you could be making 4-in. billets while changing rolls, as in order to make, say, a 2-in. billet, you must go through nearly all the motions of making a rail—except straightening, drilling, etc.—must use the whole train and the same number of men, and a 2-in. billet costs nearly as much to make as an angle bar. You should also be able to make slabs suitable for making light plates, but you roll nothing but blooms suitable for the finished material your finishing mill is adapted for.

All that is necessary to make a 4-in. billet and slabs, and any size of bloom for rails, etc., is a pair of rolls exactly the same as those in general use on a blooming mill in the United States, with the necessary room for shearing and taking care of the billets. That it is desirable to find a market for such sizes as you can make on your blooming mill while changing rolls is evident, seeing that your German competitors have recently adapted their mills to take a 5-in. square billet, which they roll at one heat into wire rods; in fact, in some places they take a 6-in. or 7-in. bloom and roll it into rods at the one heat. These blooms are sold at a lower price than a 2-in. billet, as they are able to make those sizes on their blooming mill while changing rolls. This is leakage No. 1—adding to the cost of all the material you make on your reversing blooming mills.

Next is the time lost on account of the irregular way in which you keep your mill filled up with material. In America, the greatest effort is made to find something for the blooming mill to do while changing rolls, and to keep the mill continually full of material. It is an acknowledged fact in regard to American mills, that stoppages from breakages or some unseen cause are considered a misfortune by the management. Time lost through not keeping the mill full is considered a crime, and results in the immediate dismissal of the responsible party. Go to the manager's office in connection with any well-established steel plant, and you will see on record a statement of what has been done in every department during every hour of that day, and the cause for every minute of lost time, if any. But it may be said by some, that owing to close attention to this point, the American mills and engines are better constructed than those in Great Britain to stand what you may call undue pressure. As to this point I would say that the blooming mill holding the world's record for the production of 4-in. billets per 24 hours (having produced 1,260 gross tons in that time, from an 18 × 20-in. ingot weighing 5,500 lbs.) is at the plant of the Lorain Steel Co., Lorain, Ohio, and is driven by a Galloway engine. In justice to the English engine builder, I may add that no engines in the United States give better satisfaction than the three Galloway engines at the plant of the Lorain Steel Co.

RAIL MILLS.

We will now briefly consider your rail mills. Why is it that you do not make a larger tonnage on them? Is it because you do not desire to? If this is the case, I have nothing further to say on that point. However, if the reply is that you cannot find a market for any more tonnage, then I will ask why the American manufacturers ship so many thousand tons of rails to the foreign markets that were once yours, and underbid you to get orders? Why is that you are making rails on every two-high reversing mill in your country, and in doing that not only losing your orders for rails, but allowing thousands of tons of tin plate bars to come into your tin plate districts, whereas if you could produce more rails in a given time, you would have more time to make tin plate bars. If your rail mills are not so well adapted as they ought to be for making rails or tin plate bars, is it not better to remedy the evil than to lose trade?

Are you taking out the maximum production from the rail mills you have, and have you the best adapted mills for making tin plate bars? I question as to both these points from what I have seen in this country and in the States. Do you keep your rail mill full of steel from six in the morning to six at night, as they do in the United States, where this is the rule and not the exception? If not, then that is one reason why you cannot show the same production and manufacture as cheaply. Do you keep two bars in the roughing and two bars in the finishing at the same time? If not, then you differ from the American practice—this of course on three-high mills—and this is another reason why your output is not so great. But are your reversing mills adapted so that two bars can be handled in the same pair of rolls at the same time? Perhaps not, but such is the difference in conditions.

It is my opinion that you try to roll too many different kinds of shapes and sizes on the one mill, making your reversing mill a "Jack of all trades and master of none." For a jobbing merchant mill, in my opinion, no mill is more suitable than a reversing mill, and when the Lindsay Coil clutch gains the full confidence of the steel manufacturer, a reversing mill for rolling large sizes of merchant bars will become more popular than ever. However, in view of what is being done in the United States, we cannot admit that it is the best type of mill for rolling rails.

TIN PLATE BAR MILLS.

One of the "stock" arguments of the British iron and steel manufacturer, when his attention is drawn to the large production of the American rolling mills, is as follows:

> If we had such large demand for such special material as you have in the United States, we would not hesitate a moment to put in special mills and appliances to handle the material, and produce as much and as cheaply as you do.

What about tin plate bars? Prior to the year 1892, few, if any tin plates were made in the United States, and yet she was the largest user of tin plate in the world. For years previous to that time the United States imported from Great Britain from 300,000 to 350,000 tons of tin plate per annum, and this was but 75% of what Great Britain made. Here we have a demand for about 440,000 tons of tin plate per annum, calling for approximately 550,000 tons of tin plate bars every year. Isn't that a sufficient amount of special material to induce some one to put up special mills for making tin plate bars? It seems not, for if anything, the mills you make tin plate bars on to-day (after losing nearly all of that trade) are better than they were when you had almost a monopoly in the manufacture of tin plate for the world; so you must confess that due diligence was not used with a view to taking advantage of the favorable conditions at that time. What did your American cousins do, with the demand for tin plate bars about 100,000 tons per year less? Why, some of the best, if not *the* best, machines we have in the United States for the rolling of steel are mills for making tin plate bars; and to-day they are pushing their tin plate bars in thousand-ton lots right into your tin plate districts. Among the most noted tin plate bar mills in the United States are those at the following plants: The Duquesne plant of the Carnegie Steel Co., the National tin plate bar mill at Youngstown, O.; the Bellaire Steel Co., Bellaire, O.; and the mill at Vandergrift lately owned by the Apollo Steel Sheet Co. (all of which mills have been seen by many of you). Each of these mills is of a special type, and from the ingot to the finished bar—even to the placing of the latter on the cars—all of the work is done by machinery. The result is, steel plate bars are sold for $1 per ton above the price of the cheapest steel product in the country, i. e., a 4-in. billet. In some cases they are sold on even a smaller margin. It is true that these mills cost a great deal to build, but money is no object to the American manufacturer if he can but see a fair return. I must confess, from my experience and observation, that the British manufacturer is rather conservative on this point. Here you are to-day with a large tin plate trade, and no effort is being made to prevent foreign competitors shipping tin plate bars into the country from mills 3,500 miles away.

STRUCTURAL STEEL MILLS.

In regard to structural steel, I will speak but briefly, as I cannot see such a marked difference in the British and American methods. The Carnegie Steel Co. roll all of their structural steel on the three-high system, while the Pencoyd Iron Works roll their material partly three-high and partly two-high; and opinion is pretty evenly divided as to which system is best and will produce the larger tonnage. However, on a three-high mill, the ingot must be cut into two parts, and also the first and last end of the shaped bloom. Thus while the cost of labor may be less on a two-high reversing mill, the percentage of finished product is greater. I understand, the two high-mill is commonly used in this country and on the Continent. It appears to be about a standoff between the two systems.

PLATE MILLS.

It may seem strange to hear an American say that he believes a two-high reversing mill for rolling plates to be better than the three-high mill with the small roll in the middle; but I must frankly confess that such is my opinion—this, bear in mind, for plates 5-16-in. thick and above. Were it not that a reversing engine takes more steam than a positive running engine, I think there is no question of the advantages in favor of a reversing mill. I base my opinion on the following:

First—There are no lifting tables required, which are very hard to keep up.

Second—If the three-high mill is better adapted to roll thin plates, the reversing mill is better adapted to roll thick plates. Placing a 5 or 10-ton slab on a lifting table necessitates the waste of just so much energy in raising and lowering the slab.

Third—A reversing mill is better adapted for having extra sets of finished rolls, which adds to the life of the rolls, and gives a smoother surface to the plate.

But then it may be said, "Look at the enormous output of the American three-high plate mills, some of which have made over 10,000 tons of finished plates in a single month." To that I will

reply, "Keep a two-high reversing mill as full of material as they do in the States, and your product will be no less—in fact, it ought to be greater."

Go at any time during the day or night to see a three-high plate mill in operation at the Homestead Works of the Carnegie Steel Co., where, as regular as the tick of a clock the slab is placed on the table which carries it to the rolls—one slab after the other, when the plate is going through the last pass. In fact, the slab has often to be stopped to give time for the rolls to be raised to the proper point to suit the slab's thickness. Do the same thing on some of your modern plate mills in Great Britain, and then mark the increase in the output. In rolling a plate ⅜-in. or ½-in. thick from a well-heated slab on a three-high mill, it is generally the custom to wait before the plate gets to the last pass or two, so as to finish the plate at the required heat, in order to get the necessary tensile strength and a smooth surface. You will observe exactly the same conditions on a first-class two-high reversing mill. If this is so, whence comes the advantage so far as output is concerned? On a three-high mill plates must be finished in such shape as to suit the market.

Indeed, I honestly believe that if some energetic American manufacturer ever puts in a two-high reversing mill with two stands of rolls, he will outstrip the present output of the three-high mill; for, while the plate is cooling to the required degree on the table of the finishing set of rolls, he will give the next slab two or three more passes in the first set. To say that the British workman cannot be as active and energetic as the American workman, if he desires to, is entirely wrong. I wish some of my American friends would visit some of your large steel works about a quarter to six, night or morning, or at the change of the turn, and see them hustle to get out all they can before the whistle blows. Again, who are the majority of the iron and steel workers of America today? They are Europeans, or direct descendants of Europeans; and the majority of them are from Great Britain.

MERCHANT IRON MILLS.

Before touching directly on your merchant bar practice, both iron and steel, I will give you my opinion as to the principal cause of your falling behind. It is simply because, up to the present time, you have had no competition, and my remarks following will prove this. Look back at your record for the past ten years, as regards the manufacture of iron and steel. True, there has been a slight and steady increase—in fact, you have not fallen behind your own achievements; but you have failed only to keep up with the achievements of others. How many new iron and steel plants have been started in Great Britain since the year 1890? Few of any importance, if any. How many millions of money have you spent during that time on improvements? I may be wrong, but I will venture to make the assertion that during the past ten years all of the British iron and steel manufacturers did not spend as much money on improvements as the Carnegie Steel Co. did in two years. And why not? Has your right hand lost its cunning? Is your ingenuity and energy exhausted? You, who were at one time the greatest manufacturers of iron and steel in the world?—I cannot believe it. It has been simply because you did not have to—could do well enough without.

Who gave to the world the Bessemer, the Gilcrist, and the Siemens processes?—Great Britain. Who taught us how to make bar iron, wire rods, hoops, etc.—The British. Who gave us the continuous mill?—Bedson, an Englishman. Who gave us what is known as the Garrett system of making wire rods?—Great Britain and Belgium. Who gave us the best type of heating furnace for heating steel billets, which is now almost universally used in the United States, and is almost a curiosity in Great Britain?—Allen, an Englishman. Who gave us the idea of a successful reversing mill?—Ramsbottom, an Englishman. I might go on indefinitely.

Yet, after Great Britain gave us all these, we Americans have improved on them to such an extent that they can scarcely be recognized, and we are to-day using them as a means to compete with you in the markets of the world. In the meantime—judging from some of your antiquated mills and methods—one would be led to believe that about forty years ago a Joshua once more commanded the Sun of Progress to stand still, and it has stood still ever since.

Yet, when it was suggested to the management of one of these plants that by the introduction of some American methods a great saving in money could be made, the reply was: "Why should I? I made over 30% on my capital invested last year, and am satisfied with that." At that same time they were rolling by hand, ¾-in. round bars in about 16-ft. lengths, making about ten tons per turn. They had one engine, which appeared to have been designed by Watt himself, driving four or five mills all as old as the hills, eight or ten shears, and I don't know what besides. Can anyone admit there is competition in a country where such conditions exist? To be able to pay dividends in this enlightened age under such conditions is a libel on progress, science, invention and ingenuity, and is an imposition and a grievous and unnecessary tax on the consumer.

I may say here that all of your iron merchant mills are not like that, but this is no fancy sketch, nor is it the only mill of this type in Great Britain. While you have some first-class mills for making iron, the main fact which I wish to impress at the present time is, that when rolling mills of this type pay dividends, it is proof that you have had little or no competition.

One of the best guide mills in the United States for rolling iron is what is called the Williams mill, located at Youngstown, O. This mill consists of a 16-in. roughing train and a five-stand 10-in. train, and they roll on this a box pile 5 ins. wide and 6 ins. high, containing over 60% scrap and less than 40% top, bottom and sides. This is rolled into ¾-in. rounds in 100-ft. lengths, and they make from 40 to 50 tons per turn. As I understand it, you have very few mills of this type in Great Britain. In fact, even in the United States this Belgian mill is not so popular as one might expect on account of its merit of being able to take a large pile and roll it on a slow speed train when the pile is short and "dumpy" and when the bar is long, finish it on a train having a faster speed, which are the main features of the Belgian mill.

MERCHANT STEEL MILLS.

As far as I can see, you have not up to the present time, taken any steps in this country toward building mills specially adapted for rolling merchant steel. In the United States, during the past two years, great attention has been paid to this. First of all it was found that the Allen type of furnace could be used for heating steel billets, whereas it was entirely unsuited for the purpose of heating an iron pile. The adoption of this type of furnace has reduced the cost of heating over 75% in labor alone, and it has been proven that the economy in fuel is equal to that of the Siemens heating furnace. One of these furnaces can heat 135 tons of 4-in. billets in a single turn, and if the Laughlin patented arrangement for dropping the billets out of the furnace on to the conveyor is adopted in connection with it, only one heater, two helpers, and a man to push the billets into the furnace, are required to operate two furnaces which have averaged over 200 tons per turn for a whole month—the total cost per ton for labor being about 12 cts. As this is the maximum output on rod mills, it is but fair to state that when using the furnace for merchant mill purposes, where the output is less, this cost may be increased to 18 cts. per ton. Without the Laughlan "dropping out" arrangement this cost is about 25% more. When we realize that this type of furnace is of English origin, and that any you may have in this country are looked upon as a curiosity, this is something to be greatly wondered at. This is one of the main agents in connection with the cheap production of wire rods and merchant steel.

Next, we have continuous trains to do away with the hard roughing down. A 4-in. billet is rolled into, say, a ¾-in. round with but four men around the entire mill, doing all the work necessary to deliver the same on to the hot-bed. This includes one man to look after the continuous train. Merchant mills of this type starting with a 4-in. billet, have produced as high as 445 tons of 1⅛-in. finished square bars in 24 hours, and have produced over 8,000 tons in a single month. The sizes rolled on these mills are from 3 ins to 1 in., wide flats, any thickness, and from 1¾ to ½-in. rounds and squares, and of course are best adapted for the middle range of sizes as per the above.

On another type of mill for making merchant steel, they always start with a billet 30 ft. long, and vary the size of the billet to suit the size of the finished bar. This billet ranges from 1½ ins. to 3 ins. square, and in some cases the bars are finished about 300 ft. long. To much credit cannot be bestowed upon the Morgan Construction Co., of Worcester, Mass. (and, by the way, Mr. Edwards, a Welshman, or a direct descendant of that nationality, is a leading genius of that company), on account of the high degree of perfection these mills have been brought to. Their hot-bed arrangement is a work of marvelous ingenuity. 165 tons of 2½ × ½-in., is the best record I know of, but the mill has a still greater capacity.

As to the merits and demerits of starting with a billet under 4 ins. square, I will say that whereas, outside of the fact that the capacity of the mill is controlled by the capacity of the furnace, as only one can be used, a 4-in. billet is sold in the open market in the United States for $1 per ton less than the smaller size billet, and the total tonnage labor to roll a 4-in. billet into a finished bar is less than $1. As it does not take more fuel to heat the 4-in. billet than is required to heat a smaller billet, it seems to me that merchant steel rolled from a 4-in. billet is delivered on the hot-bed—so far as tonnage labor is concerned—at the same cost as the 1½-in., or smaller billet, delivered at the heating furnace.

On mills of this type a merchant bar can be finished and placed on cars for less than $3.35 per ton above the cost of the billet. This includes loss, fuel for power and heating, and the cost of everything required to produce the finished bar. When we come to the time when pig iron will again be sold for $9 per ton in the United States, and 4-in. billets for $14, we will add to this $3.35 per ton for cost of conversion to merchant bars and you have $17.35 per ton as the net cost. When that time comes not only Great Britain, but Europe, will have what may be called Competition!

As you have so far made no effort in this country toward putting in mills specially adapted to rolled merchant steel, I have nothing from which to draw a comparison, except your present mills for rolling iron bars, on which you roll steel also; but I will say here that it is impossible to get up a mill having the same advantages as the American mill I have described, to roll both iron and steel.

HOOP MILLS.

If I were to be asked what I considered the finest rolling mill machinery in the world, I would without the least hesitation say the continuous hoop mill at Youngstown, Ohio, designed and built by the Morgan Construction Co., of Worcester, Mass. On this mill results are obtained which have been thought impossible, and for nicety of adjustment and precision of relative speeds it is, in my opinion, the finest display of ingenuity in this field. This mill also has derived its main wonderful features, such as flying shears and coiling machines, from a Welsh engineer, Mr. Edwards. Fancy a 1½-in. billet 30 ft. long and weighing 225 lbs., entering the first set of a continuous train and coming out of the last set ⅞-in. wide × No. 20 gage. After the hoop comes from the rolls, it is laid by a folding process on a slow-moving table, and the only one to touch the hoop is a boy with a pair of tongs, who picks up the first end and enters in into the reel, which coils the hoop up as neatly as a ribbon. The hoop is afterwards cut automatically into the required lengths for cotton ties. The output of this mill is about 45 gross tons of ⅞-in × No. 20 gage hoops, single turn.

It is impossible for tongue or pen to describe this remarkable rolling mill machine. However, mainly owing to the impossibility of obtaining a uniform size throughout the entire hoop when finished, this mill has not met with the favor one would expect. For cotton ties or hoops which do

not require to be of an exact gage throughout, it may be all right. Be this as it may, the fact is the American Steel Hoop Co., or their predecessors, have built two hoop mills since this continuous hoop mill was built, and neither of them are of the continuous type throughout. The most popular type of hoop mills are those having a continuous roughing train and looping finishing train of four sets of rolls on which it is a common thing to make 45 tons in a single turn of 1¾-in. and 1½-in. by 18 or 19 gage, or about 30 tons per turn of ⅞-in. × 20 gage cotton ties.

As to how much better these results are than those obtained in Great Britain, I will leave you to judge. From what I understand and have seen, you still have the old-style hoop mills of 10 or 15 years ago, and where your practice is most lacking, is in the means to take care of the hoop as it comes from the last set of rolls. It is no trick, on a first-class hoop mill in the States, to roll 1½-in. × No. 19 gage in 200-ft. lengths, and the piece will run out the entire length without being touched. Then again, you roll iron and steel hoops on the same mill, which prevents the adoption of certain improvements, particularly in connection with the heating of the billets.

MILLS FOR ROLLING STRIPS FOR TUBES OR SKELP.

In regard to strips, the finest mill we have in the United States for this purpose, is a three-high universal mill built by the Garrison Foundry Co., of Pittsburg, Pa., for the Lukens Steel Co., on which mill they roll from 10 ins. to 36 ins. in width. They have but the one set of three-high rolls. I understand this mill is giving very good results, but the manufacture of this class of material, strange to say, has not been developed to any extent even in the United States. One reason for this is that it is but lately that the consumer has become reconciled to the use of steel pipe, the material for which alone will permit of any extensive and marked improvement in the method of manufacture. However, with what we have, our practice is far ahead of yours in this country. On an ordinary 10-in. train, over 60 tons of 4¼-in. × 10-in. strips have been produced in a single turn, and between 60 and 70 tons of from 6-in. to 10-in. strips per turn is a common thing on a 16-in. mill. This refers to steel strips. I understand that in Great Britain you pay double the price for rolling strips you do for bar iron, whereas in the United States we pay less than for rolling bar iron. Special rates of wages are allowed the manufacturer by the Amalgamated Association, to men rolling strips. This is no doubt owing to the fact that at one time nothing but cut nails were used in the United States, of which over 6,000,000 kegs were made in a year, calling for over 300,000 tons of 12-in. to 14-in. strips. This made the rolling of strips so familiar and common, and competition became so keen between the cut and wire nail that reduction after reduction took place, which was naturally felt by the strip and skelp makers; and most of those nail plate mills, as they were called, are rolling strips to-day. As the methods of rolling strips are about the same in both countries, I will close the subject by making the prediction that within the next five years more improvements will be made in the direction of improving the present method of making strips than in connection with any other process in the steel business, as the demand for the same is growing greater every day, and a production of 250 to 300 tons of strips per turn, varying from 10 to 22 ins. wide, will be a common occurrence.

WIRE ROD MILLS.

I touch upon the subject of wire rod mill practice last of all, because the striking developments and results by the American rod mills speak for themselves; therefore, I will not take up your time with this at present, but will refer you to an article published in the "Iron Age," issue of Feb. 22, 1901; to another article on the history of the 4-in. billet, published in the "Iron and Coal Trades' Review," issue of March 8, 1901, and to the address of Mr. Charles H. Morgan, before the 1900 meeting of the Society of Mechanical Engineers, which gives the Morgan Construction Co. due credit, in a very modest way, for all they have done to improve rolling mill practice. There are two well-defined types of wire rod mill in use in the United States, viz.: the straight continuous and the improved Belgian types; the latter is commonly called the "Garrett" mill. Judging the popularity of both these types of wire rod mill from the number of each in use, the continuous mill would cut but a small figure were it not for the mills of this type in operation at the works of the Washburn & Moen Co. (now belonging to the American Steel & Wire Co.), at Worcester, Mass., and at Waukegan, Ill. These have of late been perfected by Mr. F. H. Daniels, Chief Engineer of the American Steel & Wire Co. to such an extent as to become quite a formidable rival to the looping type of mill. Indeed, it is only justice to say that Mr. Daniels is the only one who ever designed and constructed a continuous wire rod mill that could successfully roll more than one rod at the same time, and his last effort—in the wire rod mill at Waukegan, Ill.—is a masterpiece in that line. This mill starts with a 4-in. billet, and its output is nearly equal to that of the best looping mills—about 350 tons to the double turn, whereas the Morgan continuous mills—starting with a 1¾-in. billet, produce about 150 tons per double turn.

Concerning the rod mills of Great Britain, I understand that at Middlesbrough you have a straight continuous rod mill which has been in operation for some time; but for some reason or other, another mill recently put in was of the Belgian type. Messrs. Richard Johnson & Nephew, of Manchester, have a rod mill partly of the continuous and partly of the looping system. They, through Bedson, were the pioneers in introducing the continuous mill; but they have changed from the straight continuous mill to part Belgian. The roughing train is continuous and has vertical rolls in all cases, to reduce the ovals to a square. This is the finest mill of its kind in the world, and the manner in which these vertical rolls are driven shows remarkable engineering skill. But why have vertical rolls, which prevent you from rolling more than one bar at a time, when the "twist" guide will do the work just as well, and you could have all of your rolls horizontal?

You have a four-high mill at Warrington which is much more complicated than a good Belgian mill. On this mill the bar, when it is square in cross-section, is carried by means of what we might term a split pipe from the top two-high set to the bottom two-high set—the latter set being speeded up in proportion to the reduction. This is accomplished by a curved guide on all Belgian trains, which saves the same labor and has no complication, and the output of some of the Belgian mills in Germany exceed this mill. Thus this again seems a case of "much ado about nothing."

Then you have some of the very oldest types of rod mills in Europe, and to show how far you are behind in output at least, I will make the assertion that the four best rod mills in Great Britain, during the month of January, did not produce as many rods as one of the wire rod mills in the United States, which during that month produced 10,230 gross tons of No. 5 rods—indeed, I might make it five of your best mills and be safe. Here we have five different concerns—five mills, five crews of men, five rollers (skilled men), five heaters (skilled men), paying the rollers, say, 25s. per day each, or £6 5s., and the heaters 15s. per day each, or 75s., making a total of £10 ($50) for each turn's work, instead of one roller, $12, and one heater, $6, or $18, or over 75% less, not to speak of the balance of the men. I wish it to be understood that in my opinion the best men around the rod mills I ever saw are those who work on your present mills in England, so it is not the fault of the men.

The question might be asked: "If each of these five rod mill owners had a rod mill of that capacity, what would they do with such a production of rods?" This I cannot answer, but if the present method of making rods is persisted in, the time will soon come when you will not make any rods, as there is already quite a surplus of rods in the United States. Unless your steel makers find some means of giving you a cheaper 2-in. billet, to meet which price the American steel makers may not find it to their advantage, the Americans will deliver wire rods to England at a figure less than you are now paying for 2-in. billets.

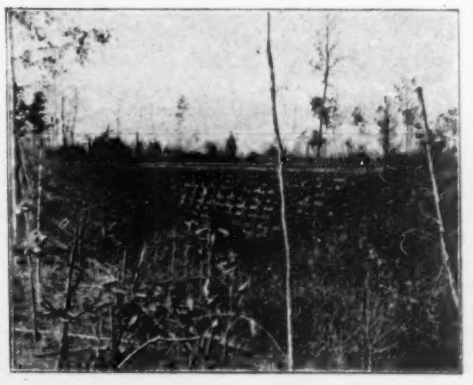
Is there no remedy, and will Great Britain give up the wire business?—She, who was the mother of that business, and has taught the world how to make wire?—I think not, and I believe there is a remedy which will be eventually adopted. Suppose the five largest users of wire rods in Great Britain were to combine and erect a large first-class rod mill, but keep their own business just as it is, and each party take stock in the new rod mill deal in proportion to the amount of rods they would use. They could treat this new enterprise as an entirely new organization from their present wire-drawing plants; locating the new plant not far from a shipping port on either the East or West coast.

Let us see how they would stand with a view to securing their raw material in the shape of billets. So far as their supply from Great Britain is concerned, conditions would be the same as to-day; but they could not only draw their billets also from the Pittsburg district, as they are doing at the present time, but could also command a supply from the Tennessee Coal, Iron & Railroad Co., of Birmingham, Ala., who are located but a short distance from the seaboard; from the Maryland Steel Co., of Sparrows Point, Md., and from the Dominion Iron & Steel Co., whose plant is located at Sydney, N. S., or 1,000 miles nearer Liverpool than New York is. No better source for a supply of billets than this last-named concern could be had. When keen competition comes, the Dominion Iron & Steel Co., who can make the cheapest pig iron in the world, will always be able to make steel billets at a low cost. This same scheme can be applied to all who now make rivets, bolts, etc., or to those who make tubes or pipe, buying soft steel billets to make their strips. In fact, if your raw materials, your ore and coal, are becoming scarce, and you can find a better market for your coal, selling it for steam purposes, than to manufacturers of pig iron or steel, who during times of competition must have cheap coal, I can see no better scheme for you. Why import ore, which has over 50% of foreign matter, when you can import billets on which there is but from 5 to 6% loss from the billet to the wire rod, merchant bar or steel strip? This same rule can be applied to those who use strips for tubes.

If the British iron and steel makers do not follow the footsteps of their American cousins and combine, and then manufacture their respective materials only at the most advantageous points for shipment and use the most economical method in manufacturing, the manufacture of iron and steel will in time become a lost art in Great Britain.

A CRIB BRIDGE ON A LOGGING RAILWAY IN MICHIGAN.

The accompanying illustration represents a curious structure in the form of a crib bridge on a logging railway. This bridge, which is near Kalkaska, Mich., is about 30 ft. high and 250 ft. long. Heavily-loaded cars are hauled over it daily at high rates of speed. For the photograph from which our cut is reproduced we are indebted to Mr. Job Tuthill, Assistant Engineer of the Pere Marquette R. R.



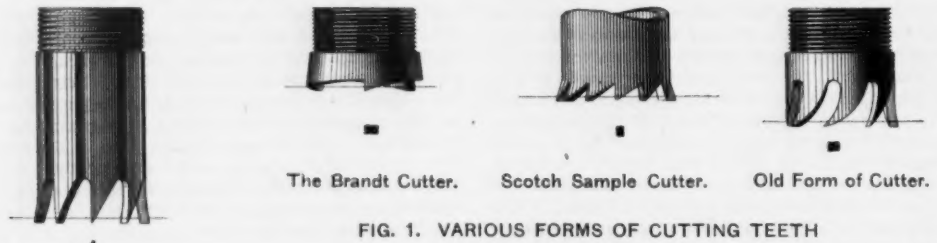
A Place Where Timber is Cheaper Than Dirt.

THE DAVIS "CALYX" CORE-DRILL.

We illustrate herewith a new type of core-drill which was invented a few years ago in Australia by Mr. F. Harley Davis, and is now being introduced in this country by the Davis Calyx Drill Co., 128 Broadway, New York city.

The Calyx drill is a rotating drill, with an annular cutter, like the well-known diamond drill, and, like the latter, it cuts a core out of the rock. It also, by means of the "calyx," which will be described later, furnishes the chips cut from the rock in regular sequence as they are cut, thus giving a duplicate record of the boring.

The first elementary feature of the drill is the cutting tool, which is shown at the left of Fig. 1. A detail of a portion of it is shown in Fig. 2.



The Davis Cutter. The Brandt Cutter. Scotch Sample Cutter. Old Form of Cutter.

FIG. 1. VARIOUS FORMS OF CUTTING TEETH FOR ROTARY CORE DRILLS.

It is evident that a simple steel pipe with one end cut in saw-tooth shape, if heavily weighted and slowly rotated, will cut or grind its way through rock, if the rock is not too hard, until the teeth are ground flat. Three such cutters, in addition to the Davis cutter, are shown in Fig. 1. The first is the Brandt cutter, which is used in the well-known Brandt rotary hydraulic drill, with which most of the great Alpine tunnels have been driven, including the Simplon, now under construction. It will be seen that after the Brandt cutter has worn down a certain distance, the face of each tooth will present to the rock a flat surface of considerable area, as shown in the cut, and the tool will then cease to cut. The next tool is known as the Scotch sample cutter, in which the tooth has an angle of about 45°. It is soon blunted and rendered useless. The fourth is another old form of tooth which also soon wears down to a flat surface, and becomes inefficient. At first sight it might be supposed that the Davis cutter, with its sharper angle of tooth would wear down more rapidly than the others; but the fact is that its action is entirely different from that of cutters

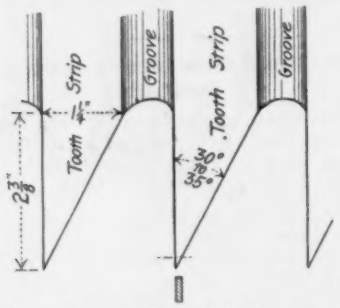


Fig. 2. Detail of Davis Cutter.

to great pressure the sharper tooth sinks into the rock, and the energy stored in the twisting of the with the blunter forms of tooth. When subjected rotating rod which actuates the cutter gives the latter a sort of jumping or chattering action, causing it to spall off fragments of considerable size, leaving the cut surface of the rock a series of alternating ridges and valleys. The cutter, therefore, has a sort of hammer-and-chisel action, cutting the rock into small chips. Fig. 3 is reproduced from a photograph, and shows the actual size of some of these chips. It has been found by experience that the teeth of the cutter should be 2⅜ ins. long on the vertical face, 1¼ ins. wide at the base, and 7-16-in. thick. As the teeth wear shorter, the angle of their edges changes, say, from 30° to 35°. Fig. 2 shows on a larger scale than Fig. 1 the shape of the teeth, together with a groove or channel cut in the exterior of the pipe, parallel to the vertical edge of each tooth. When the teeth wear down to a length of 2 ins. they require to be re-cut.

The next peculiar feature of the drill is the calyx, shown at D, in the general sectional view in Fig. 4. A calyx is defined in the dictionary as "a cup-shaped part or organ." The office of this part of the drill is to receive the chips of the rock and hold them until they are removed, together with the core. The manner in which it collects the chips will now be explained.

Referring to Fig. 4, A is the cutter, B is the core barrel, a tube of the same outside diameter as the main body of the cutter. The hollow drill rod F is formed of a series of tubes joined together, and its lower extremity is screwed into the upper end of the core barrel by means of the reducing plug, C. The calyx, D, is a tube equal in diameter to the core barrel. It surrounds the drill rod, rests on the reducing plug, and is open at its upper end. There is a space between the drill-rod and the inner surface of the calyx, in which the rock chips are deposited from the current of water which carries them upwards from the cutter. The water is pumped down through the drill-rod to the cutter, thence it passes outwards through the teeth of the cutter, and rises at a high speed through the narrow passage between the core barrel and the bore in the rock, carrying with it the chips and fine particles detached by the cutter. When this stream reaches the top of the calyx its velocity is suddenly checked, on account of the larger area provided for it to flow in, and the rock particles fall into the calyx, while the water proceeds to the surface. By means of the calyx the bore is kept free from cuttings and sludge.

Fig. 4 shows the ordinary method of operating the drill. Power is received through a horizontal shaft, and is delivered by bevel wheels to a horizontal wheel which grips the drill-rod by suitable mechanism. Water is furnished to the drill-rod from a pump by means of a hose. The hook shown at the top of the drill-rod is for the purpose of hoisting the drill-rod, with its attached cutter and calyx, together with the core of rock, from the bore.

The Davis cutter will cut almost any kind of rock. Sandstone and hard shales have been penetrated at the rate of ¾-in. per revolution of the cutter. With harder rocks it is found that it is preferable to use chilled iron or steel shot, or crushed steel, instead of the pointed tooth cutter. This is held in a serrated ring or bit, which is screwed to the drill-rod in place of the cutter. The calyx is used with the shot in the same manner as it is with the cutter.

It is found advantageous in boring some rocks, which vary in character at different levels, to use the Davis cutter, with the chilled shot process alternately, as softer or harder rock is encountered. The Davis cutter will cut hard rock, but will cut it slower than the chilled shot, but the latter will not work if a crevice in the rock is struck, and then the Davis cutter must be used.

The drill is manufactured in different sizes, capable of taking out cores from 2⅜ to 10¼ ins. diameter. The half-tone cut, Fig. 5, shows a core 10 ins. diameter, 6 ft. 6 ins. long, which was taken from a bore hole 11¼ ins. diameter, drilled at Broadway and 74th St., New York city, for the Stokes Apartment Hotel. The rock is the usual hard micaceous shist of Manhattan Island, traversed by thin quartz veins at an angle of about 80°. The chilled shot process was used in this case. The drill that made this core was purchased by the Plunger Elevator Co., of Worcester, Mass., and is being used to drill holes 200 ft. and over in depth for the purpose of installing the direct-acting plunger hydraulic elevator. The drill is driven by a 30-HP. electric motor, and on March 15 it was down a depth of 127 ft., which depth was reached in 115 hours' actual drilling time.

ANNUAL CONVENTION OF THE AIR-BRAKE ASSOCIATION.

The eighth annual meeting of the association was held at the Leland Hotel, Chicago, April 30 to May 3. The attendance was large and the meeting-room provided in the hotel was insufficient to accommodate all the members present, even with uncomfortable crowding. Mr. O. Best (N., C. & St. L. Ry.), First Vice-President, occupied the chair and delivered the annual address, after which the reading and discussion of the special committee reports were begun.

THE PRESSURE RETAINING VALVE.

The report stated that the following well-known facts make necessary the use of the pressure retaining valve when trains are descending steep grades:

1. Either because of too much holding power, resulting from an undesirably heavy application, train-pipe leakage, lighter grade or sharp curves, or by reason of reduced auxiliary reservoir pressure, due to supplying the leakage from brake cylinders the triple valves must occasionally be moved to release position; in the first instance to reduce the holding power and in the second to recharge the auxiliary reservoirs.
2. The release position of the triple valve will, so far as it is concerned, result in a quick and full discharge of all brake cylinder pressure, yet, at the same time, permit of but a comparatively slow recharge of the auxiliary reservoir.
3. In the absence of any holding power the speed increases rapidly.
4. As on steep grade, it is not necessary, under the conditions mentioned, to have all brake cylinder pressure released, any unnecessary reduction results in more being required from the auxiliary reservoir on reapplication. This makes it more difficult to keep recharged and increases the pump labor.

As is well known, the pressure retaining valve is connected to the exhaust port of the triple valve, and, in its cut-in or retaining position, will, when the triple valve is moved to the release and recharging position, permit of a slow discharge of any brake cylinder pressure over 15 lbs., but will retain this amount. This refers to the modern valve. It was preceded by the valve that permitted of a much more rapid discharge of any pressure over its limit, the latter being but 10 lbs.

The report called attention to the fact that it was a very common thing to find that the retaining valve was inoperative because of defects of application and maintenance, and pointed out that the question of improving this condition was one of vital importance to railways having heavy grades. The remedy suggested was as follows:

The cleaning and lubricating of the air brake must be made to comprehend cleaning and testing the retaining valve as well as the remainder of the brake apparatus. In fact, it should embrace all work needed to put the entire brake apparatus in good order. Retaining valves located in positions that prevent their handles being operated when the train is running should be relocated. All valves in service should be required to pass the following test: Following the application and release of the triple valve

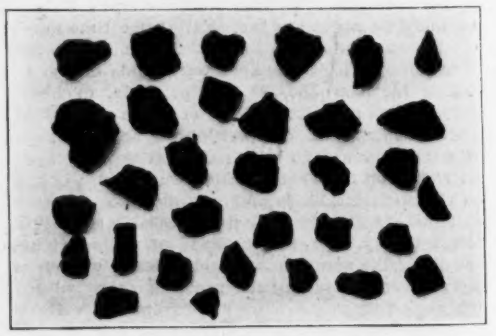


Fig. 3. Chips from Davis Cutter (Actual Size).

it should be impossible, one minute after the exhaust ceases at the retaining exhaust port, to move the brake-shoes by a push with one's foot on the end of a brake beam, and a strong exhaust must follow when the retaining-valve handle is turned down at the end of the same period of time.

DISCUSSION.—The discussion developed the fact that on many roads (mainly those with easy grades, on which the use of the retaining valves is not essential) the maintenance of the retaining valve is seriously neglected. It was suggested that all roads ought to pay as much attention to this as to any other part of the brake equipment, and that when cars are delivered at interchange points with defective or inoperative valves, the cost of necessary repairs should be charged to the delivering road. The discussion also indicated that many roads are using the hand brakes as a precaution in descending heavy grades, and Mr. Desoe (Boston & Maine R. R.) questioned whether it would not be better, as a matter of mere safety alone, to handle trains entirely by the hand brakes on such grades, rather than to rely on the retaining valves, in view of their frequent defective condition.

It was also shown that many car-building firms apply the brake apparatus incorrectly and leave the pipes choked with dirt and scale, instead of blowing them out, so that new cars often require very considerable overhauling on the part of the air-brake inspectors.

Following the discussion of this report a short address was delivered by Mr. G. W. Rhodes, Assistant General Superintendent of the Burlington & Missouri River Ry., in which he outlined in an interesting manner the brake tests of 1885, 1886 and 1887, with their lessons and their results. Some remarks as to the relations between the Air-Brake and Master Car Builders' associations, were made by Mr. J. T. Chamberlain, Master Car Builder of the Boston & Maine R. R.; his remarks referring more particularly to suggestions for changes in the rules of interchange in regard to the use of retaining valves. In the afternoon of April 30 there was a steamer excursion on the river and lake, and a theatre party was given in the evening.

On May 1, the discussion on the retaining valve was continued, and the report of the committee on "Air-Pump Exhaust for Heating Passenger Trains" was read by Mr. Frank F. Coggin (Me. Cen. R. R.).

AIR-PUMP EXHAUST FOR HEATING PASSENGER TRAINS.

The report stated that while many attempts had been made to heat passenger trains by the exhaust from air

Fig. 5. Ten-Inch Core of Gneiss Rock Removed with Davis Calyx Drill.

brake pumps, they had not often met with much success. One of the chief difficulties consisted in the large amount of water which was discharged from the pump. The action of the pump while on the road was intermittent. While the pump was inoperative, or nearly so, much condensation took place, both in the steam cylinder and the pipe leading to it, and on each restarting of the pump this condensation was discharged along with the steam, the first few exhausts containing much water. If this exhaust were to be discharged directly into the heating pipes of the train, the result would be to fill the pipes with water and the heating results would be poor; again, it would be very difficult to obtain a good circulation through the radiators of the cars, particularly with trains of any length. This difficulty seemed to have been entirely overcome by the method used for the last two winters on several of the largest roads in New England, a brief description of which was as follows:

The device consists of a three-way cock placed at or near the pump in the exhaust pipe, and a rod leading back into the cab and having a handle. On this handle being pushed forward, all the exhaust goes to the stack or saddle, as was the former practice. On the handle being pulled back, all exhaust steam and condensation are discharged into a trap or reservoir. This reservoir is ordinarily located under the running board of the cab and, as a rule, is about 44 ins. in length and of as large a diameter as will hang up and not project beyond the cab line, and is lagged with a good non-conductor of heat and is also jacketed. The purpose of this trap or reservoir is to re-evaporate the water of condensation which comes from the pump on each restarting of the same, the operation of which is as follows: The water discharged from the pump along with steam on the first few exhausts which, while hot, is evidently not hot enough to evaporate under the high pressure in the pump, which working against say 90 lbs. main reservoir and say 30 lbs. back pressure, would make a total resistance of about 120 lbs. to be overcome at the pump, and would need upward of that pressure in the steam cylinder, or say 130 lbs. of steam. Now, water under a pressure of 130 lbs. requires to be heated to a temperature of 356° F. in order to evaporate, and it is evident that this water is not heated up to this temperature.

On the exhaust taking place, the steam and water of condensation are discharged into the trap where the pressure is suddenly dropped to 30 lbs., and under this pressure water will evaporate at 274°, and this water flashes into steam at once, as it contains sufficient heat to evaporate at this lower pressure. Should any of the water not evaporate, it is trapped at the bottom of the receiver and held there, and each succeeding exhaust from the pump coming hotter and dryer, passing through the receiver to the train, imparts heat to what water may remain, and on the governor stopping the pump the pressure in the receiver will fall to some extent, and the result is the re-evaporation of the water which was held up at this point.

Opening out of the rear end of this reservoir a connection is made with the train line steam pipe underneath the tender. Also connected directly with this reservoir is a pipe leading up through the roof of the cab, on the upper end of which is a relief valve set at the maximum pressure required to suitably heat the train. The direct steam pipe leading from the reducing valve and boiler is also connected to the reservoir so that, should occasion require, the former method of heating direct can be used.

The rules for operating the system are:

When steam is called for from the train the handle of the three-way cock should be pulled back, the reducing valve set at the minimum pressure and the boiler valve opened. Should the pump exhaust raise the pressure in the heating system above what the reducing valve is set at, the surplus pressure will be vented to the atmosphere. Should the pressure fall below what the reducing valve is adjusted to, the boiler will automatically make up the deficiency until the pump starts up and raises the pressure. The result is that nothing will be drawn from the boiler while the pump maintains a pressure above what the reducing valve is set at.

From careful observation during the past two winters, it has been found that the enginemen do not open the direct steam valve at all on local trains, as the pump furnishes a sufficient quantity of steam for heating purposes, the relief valve being open a large portion of the time. With express trains the boiler is called on at times, to some extent, but merely makes up what the pump fails to furnish, where heretofore it was obliged to furnish all the heat.

DISCUSSION.—Mr. Coggin supplemented this paper by particulars of the successful operation of the system on the Maine Central R. R. It is used on long trains, and is ordinarily amply sufficient for as many as 14 cars, but with such trains in very cold weather it is supplemented by steam from the boiler. The system is also used on the Boston & Albany R. R. and the New York, New Haven & Hartford R. R., with satisfactory results. This discussion completed the work of the morning session. The entire afternoon session was devoted to the reading and discussion of the additional part of the air brake catechism, prepared by the Committee on "Progressive Questions and Answers," and bringing the matter up to date.

On May 2 the discussion of the air brake catechism took up the greater part of the morning, and was followed by the report of the committee on "Terminal Plants for Testing Air Brakes." The reports of the secretary and treasurer were also presented, and showed a balance of $675 in hand. The afternoon was devoted to the discussion of the report on testing plants, after Pittsburg had been selected for the place of meeting in 1902.

TERMINAL PLANTS FOR TESTING AIR BRAKES.

The report advocated testing plants for air brakes at all repair yards, terminals and relay points. New yards should be so designed and old yards so redesigned as to provide facilities for testing all trains on arrival or the tracks so piped that in making up trains cars in make-up can be placed on a piped track. The methods and cost of installing yard air-testing plants was governed almost entirely by local conditions. However, a very close estimate of the cost of installation could be based on the following figures, which showed the cost of installing the air-testing plant at the Scranton, Pa., terminals of the D., L. & W. Ry.:

Repair Track.

Pipe, 2,000 ft. 2 in., at 16 cts. per ft.	$320.00
Cut-out cocks (45), at $1.15 each	51.75
Two laborers, 4 days each, at $1.10 each	8.80
One pipeman, 7 days, at $1.75 per day	12.25
One helper, 7 days, at $1.35 per day	9.45
45 wood boxes, at 75 cts. each	33.75
Total	$436.00

Coal and Freight Yard.

Pipe, 3,580 ft., 1¼ in., at 7 cts. per ft.	$250.60
Two reservoirs, 26½ × 41 ins., at $18 each	36.00
Cut-out cocks (63), at $1.15 each	72.45
63 wood boxes, at 75 cts. each	47.25
Two laborers, 12 days each, at $1.10 per day	26.40
One pipeman, 12 days, at $1.75 per day	21.00
One helper, 12 days, at $1.35 per day	16.20
Total	$469.90

Passenger Yard.

Pipe, 1,300 ft., 1¼ ins., at 7 cts. per ft.	$91.00
Cut-out cocks (25), at $1.15 each	28.75
Two laborers, 5 days each, at $1.10 per day	11.00
One pipeman, 5 days, at $1.75 per day	8.75
One helper, 5 days, at $1.35 per day	6.75
25 wood boxes, at 75 cts. each	18.75
Two reservoirs, 26½ × 41 ins., at $18 each	36.00
Total	$201.00

Grand Total.

Cost of repair track	$436.00
" " coal and freight yard	469.90
" " passenger yard	201.00
	$1,106.90

DISCUSSION.—The discussion on this report turned largely on the necessity of testing the brakes after the train is made up, but before the engine it attached. For this some roads allow 1 to 1½ hours, but other members thought they could not afford to give so much time.

On May 3 the closing session was held, at which the report of the committee on "Unconnected Brake Hose vs.

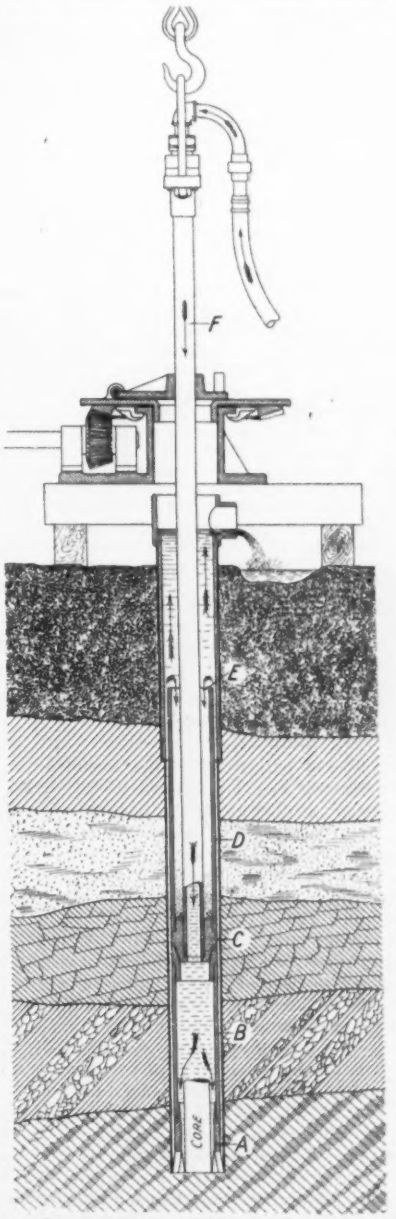


Fig. 4. General Sectional View of Davis Calyx Drill.

Dummy Couplings" was presented. This report summarized its conclusions as follows:

In view of the foregoing, it is the opinion of the committee that a well-designed and properly located dummy coupler should be used on all cars equipped with air brakes. A coupler to fulfill these requirements must be strong, so as to withstand rough usage, and allow a freedom of motion so as to give the hose its natural curve, and must cover the opening effectually. An additional requirement has been suggested that the bearing surface should be made of brass, for it has been anticipated that the hose gaskets may become ruined from the action of a corroded surface against it.

The business of the convention was closed with the election of the following officers: President, Otto Best (Nashville, Chattanooga & St. Louis Ry.); Vice-Presidents, James Goodwin (Northern Pacific Ry.); W. P. Huntley (Chesapeake & Ohio Ry.), and Frank F Coggin (Maine Centray Ry.); Treasurer, E. Desoe (Boston & Maine R. R.); Secretary, F. M. Nellis ("Locomotive Engineering"), New York.

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ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The Spring ballot list of the American Society of Mechanical Engineers shows a total of 132 candidates for admission to the Society, of which 66 are candidates for full membership, 56 apply for membership in the Junior grade, and 10 are proposed as Associates. Besides these, 17 candidates for promotion from the Junior grade are to be voted on. The total membership of the Society with these new additions will be about 2,260 or very nearly as large as the membership of the American Society of Civil Engineers, whose catalogue, issued in January last, shows a total membership of 2,350.

Following the description of the large and novel mechanical filtration plant at Louisville, Ky., in our issue of Jan. 17, 1901, we present in this number an illustrated account of works nearly as large and in some respects even more unique, now under construction at Little Falls, N. J. The Louisville plant has a rated normal capacity of 37,500,000 gallons a day, and the Little Falls plant of 32,000,000 gallons, but it is expected that each plant can be run at higher rates for short periods. Among the noteworthy features of the works at Little Falls there may be mentioned here the great depth of the coagulating basins; the use of rectangular masonry filter tanks of relatively large size, instead of the ordinary and smaller wooden or steel circular tanks; the mechanical operation and control of valves and machinery from a central point for each filter; and the use of either concrete or concrete strengthened by steel rods for the whole substructure, including the heavy floors supporting the filter tanks. While this work is going on at Louisville and Little Falls, the city of Philadelphia is getting its slow sand filtration plants, of which there will be a number of large ones, well under way. Cincinnati is building its settling reservoirs, preparatory to putting in mechanical filters, and New Orleans is proceeding with its investigations relating to the treatment of the Mississippi River water. Slow sand filtration has been adopted for Washington, D. C., by the terms of the Congressional appropriation for improving the water supply of the District of Columbia. Altogether, there appears to be no lack of interesting developments in water purification. But it may be asked, amidst this general movement for pure water, why has the city of Providence fallen by the wayside? It was the pioneer in the careful study of mechanical filtration, and several times it has been on the verge of adopting plans for purification works. Yet it seems no nearer the goal now than it was a half-dozen years ago.

Our esteemed contemporary, London "Engineering," devotes two pages of its space each week to an "illustrated patent record," in which selected abstracts from a score or so of current patent specifications are printed. We are not informed on what basis the "selection" is made; but the fact that in a recent issue, which we happen to notice, the first on the list is an American invention indicates that no insular prejudice against Yankee ingenuity exists in the mind of the selector. We reprint our contemporary's description of this invention as follows:

J. E. WELDON, PORTAGE, WIS., U. S. A. COW-TAIL HOLDER.—An improved device for preventing cows from swishing their tails while being milked, according to this invention comprises for engaging the leg of the animal, a wire clip provided with two curved portions at one end, and at the other end a spring arm with a serrated plate secured to it and adapted to grip the hair of the cow's tail. The larger loop of the curved portion is slipped over the leg of the cow, and the clip fastening is then adjusted with the hair of the cow's tail caught between the serrated plate and the wire half circle.

Evidently, as we have often heard, engineering is a far broader term in Great Britain than in the United States.

Chicago has followed the precedent of Boston by beginning the publication of a bulletin of municipal statistics. The work in Chicago is carried on by the Chicago Municipal Library and Bureau of Statistics. The library was established about a year ago "for the collection and collation of books, documents and papers relating to city affairs." It was the outcome of a suggestion by Mr. Carter Harrison, Mayor of Chicago. Later, Mr. Harrison suggested a statistical bureau, to be conducted, at least for the present, in conjuncion with the library. The first bulletin to appear contains quite a range of statistics relating to city affairs for the first two months of 1901, and a summary for the years 1893 to 1900, inclusive. It also contains some commercial and financial statistics for January and February. Mr. Hugo S. Grosser is Librarian and Statistician, with headquarters at the City Hall. It is a pity that other American cities do not undertake more scientific statistical work. New York has had a statistical bureau for three years, but it has published nothing thus far. The boards of health of a number of cities issue monthly statistics relating to sickness and death. A few annual municipal reports, general or departmental, contain summaries of statistics, but most of these are very summary indeed. As to the advantages of this sort of work, Mayor Harrison, in a communication to the City Council, said:

The beneficent reforms of the present time are chiefly due to the scientific study and comparison of statistics. A sure test of the goodness or badness of a particular measure lies in an appeal to the same source. To understand intelligently the needs of this city, one must understand intelligently the details of the operations of its institutions.

THE UNITED STATES AS A COMPETITOR IN INTERNATIONAL TRADE.

At the annual meeting of the Iron and Steel Institute of Great Britain, held in London this week, a paper was presented by Mr. Wm. Garrett, M. Am. Soc. M. E., comparing the rolling mill practice of Great Britain and the United States. We print this paper in full on another page of this issue. As many of our readers are aware, Mr. Garrett is one of the leading authorities in this country in the line of work to which his paper is devoted. His comparisons are not glittering generalities, like so much of the mat published respecting American competition w Great Britain, but plain, straightforward st ments, showing exactly the methods by wh American producers of iron and steel have fo it possible to eclipse all their competitors, a turn out products which have been carried m than three thousand miles, to the doors of E lish and German mills, and sold at lower pr than they could quote. Mr. Garrett points that America's success in the export of rolled i and steel is not due solely or chiefly to her w derful stores of cheap ore and coal. The m element in that success, as we read Mr. Garre paper, can be best summed up by the word e terprise, or, to put it in the vernacular, "hust Nearly all the great inventions in iron and st manufacture have had their origin in Gre Britain; but American manufacturers and en neers have had the energy to adopt these inve tions and develop them to a point of which th originators never dreamed.

Mr. Garrett does not, like so many of th writers on this subject, place the blame fo British failures to keep pace with the Unite States upon the workmen or on the trad unions. He explicitly states that British workm are equal to those found anywhere. Given de cent wages, fair treatment and an incentive to d their best, and the same men of whom British manufacturers so much complain form the best employees that an American mill manager can find.

It is on the owners and managers of British iron and steel works that Mr. Garrett lays the chief responsibility for the waning prestige of the British iron trade. Unless they are ready to adopt modern improvements to bring their mills up to date, and modern methods of rapid operation, he sees no chance that they can retain a place in the world's competition.

To those who are interested in the story which Mr. Garrett tells, and who desire to pursue the subject further, we can heartily commend a little volume recently published by Harper & Brothers, entitled "American Engineering Competition."* It is a reprint of a series of articles published in the London "Times" during the past twelve months, written by an English engineer who visited many of the principal iron and steel works and manufacturing plants in the United States for the purpose of investigating American conditions and determining the cause for the appearance of such large quantities of American goods in foreign markets. The main part of this book is devoted to the iron and steel industry, the same field to which Mr. Garrett directs attention, and the conclusions reached by the two authorities are practically identical.

The London "Times" writer has been criticised, probably justly, for giving too roseate a view of conditions in the United States. Perusal of the volume, however, indicates that this error, where it occurs, is due to lack of information, rather than to intentional exaggeration. The author evidently meant to preserve a perfectly judicial attitude and to give American manufacturers credit only for what the facts showed they deserved.

We especially commend this subject to the attention of our readers, because it seems to us that at the present time these studies of international competition are of large importance to the American people. It has been repeated time and again that the future wars are to be wars of commerce, and that the greatness of a nation is to be judged by the volume of its exports; but a fact which has been to a large extent lost sight of in discussions of the United States export trade and its growth during the past decade, is that the character of the exports counts for a great deal.

A nation's stores of coal, of minerals, of lumber, are sources of natural wealth which once exhausted cannot be replaced. Prices of all these staple articles of consumption are determined in international trade by world-wide competition, and profits consequently are always small, and in the long run represent the lowest cost at which the business can be continuously carried on. The

*The book is a cloth bound 12mo. of 139 pages and its price is $1.

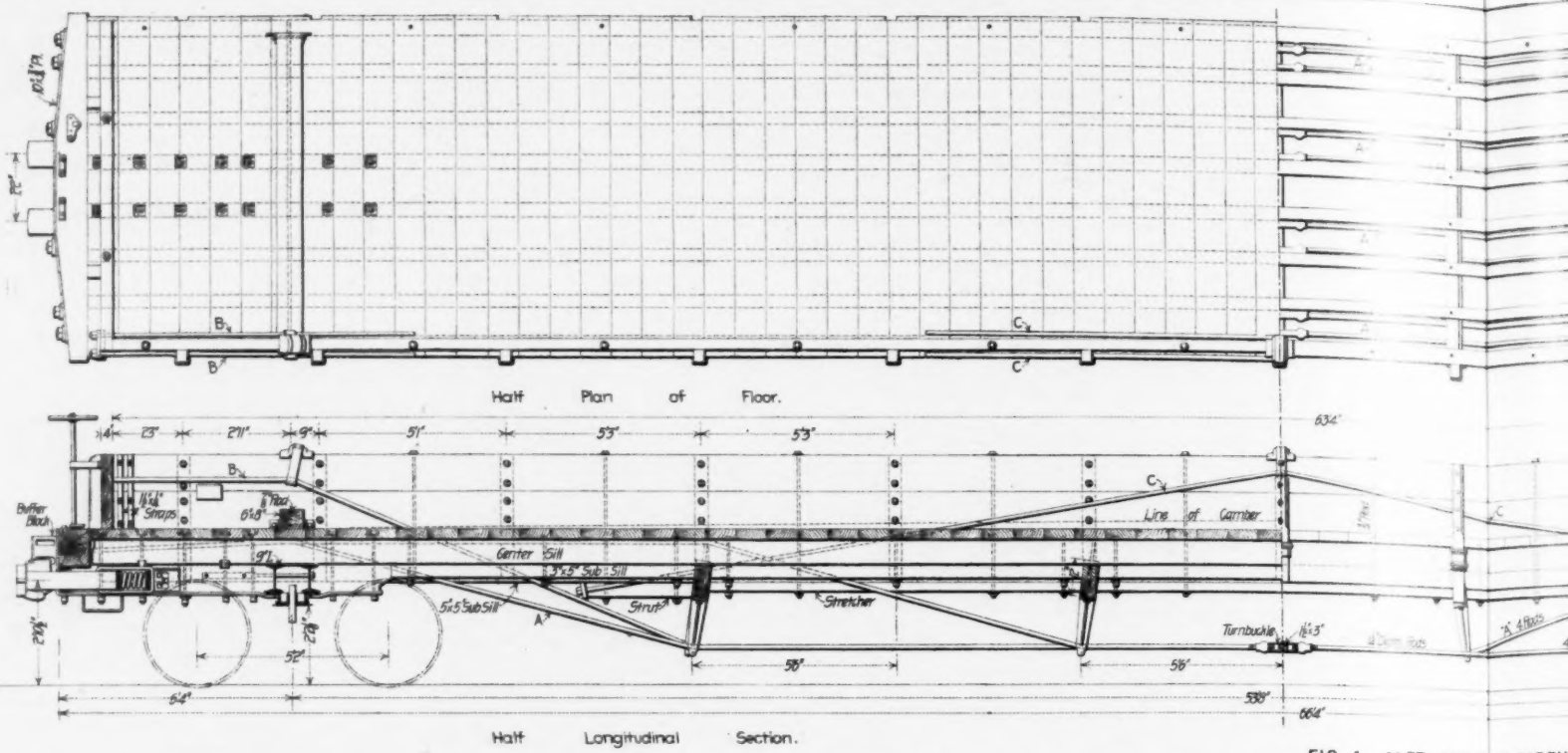


FIG. 1. 66-FT. CAR FOR CARRY

FIG. 2. DRAFT RIGGING OF RAIL CAR.

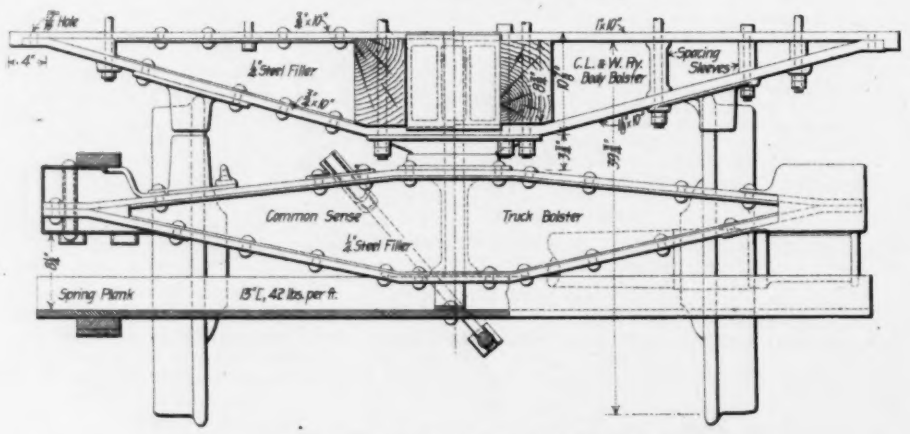
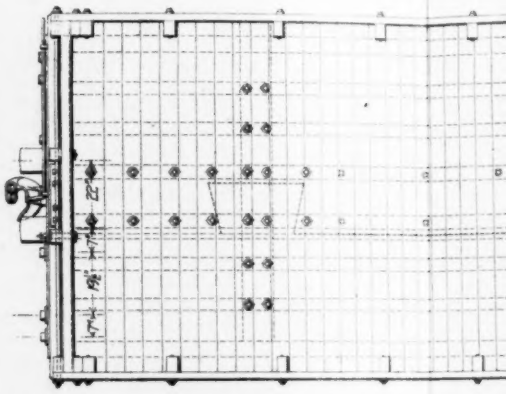
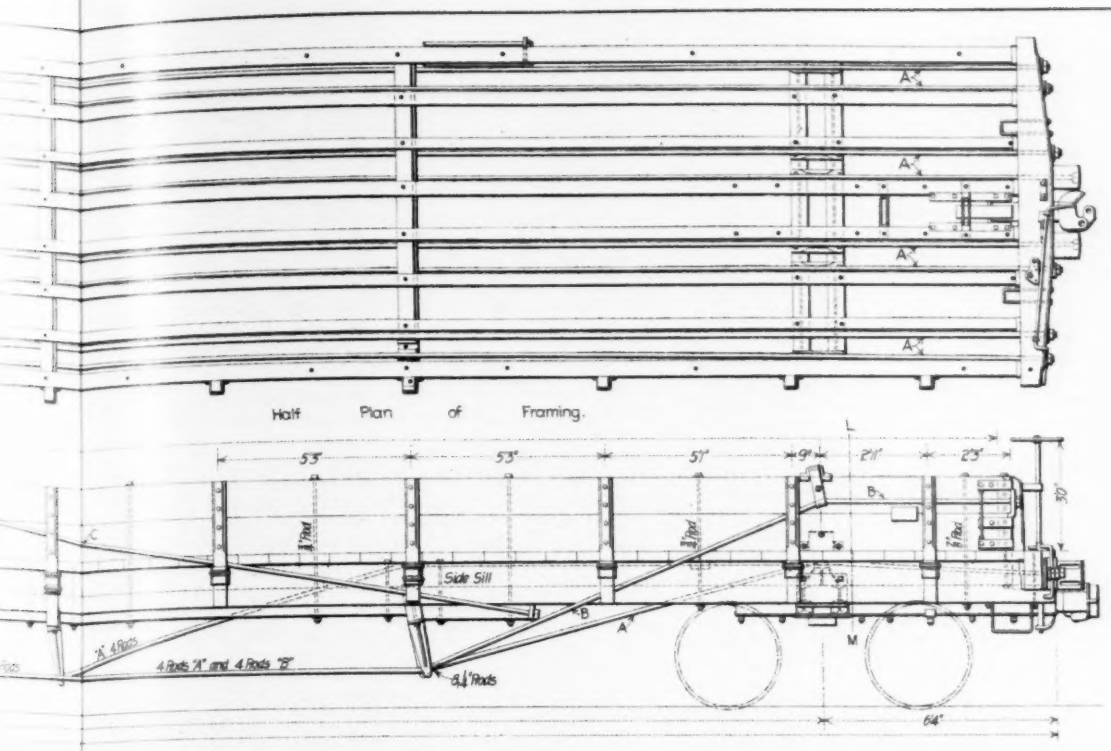


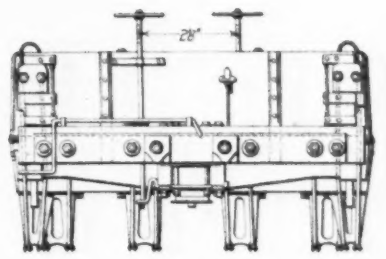
FIG. 4. BODY BOLSTER AND TRUCK BOLSTER OF GONDOLA CAR.

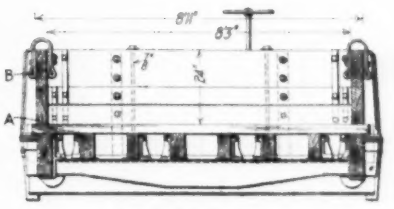


66-FT. RAIL

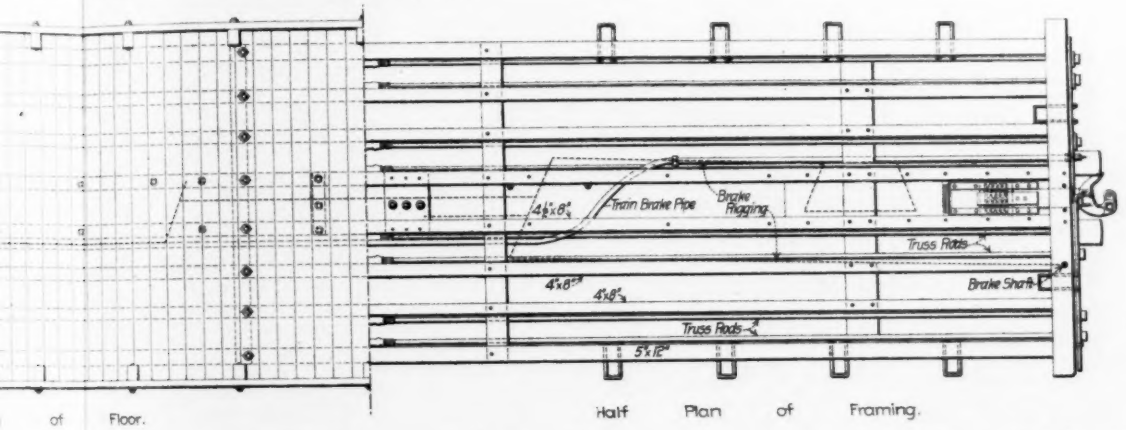
F. H. Stark, Master Ca

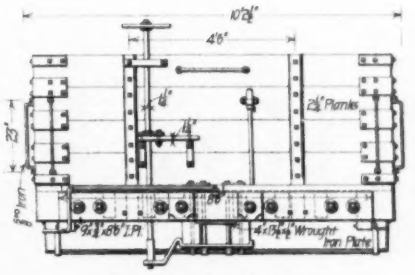


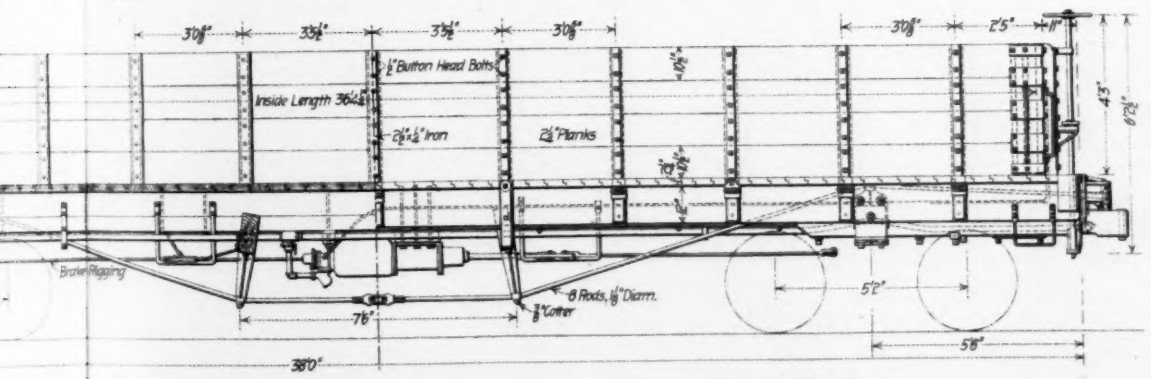


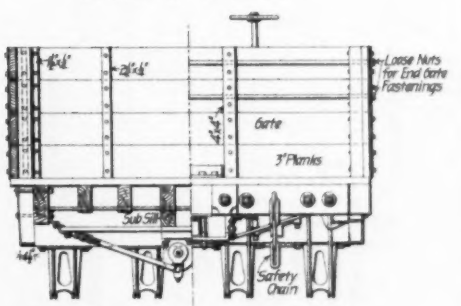


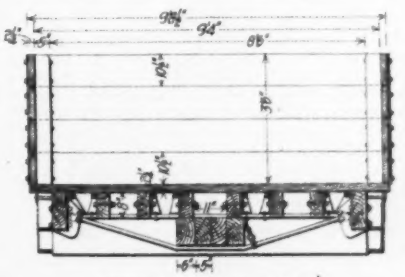
FT. CAR FOR CARRYING RAILS; LAKE TERMINAL R. R.











gitudinal Section.

FIG. 3. 38-FT. GONDOLA CAR; CLEVELAND, LORAIN & WHEELING RY.

66-FT. RAIL CARS AND 38-FT. GONDOLA CARS.

Stark, Master Car Builder, Cleveland, Lorain & Wheeling Ry., Designer.

CHAS. HART, LITH., 98 VESEY ST., N. Y.

same thing is true, to a large extent, of agricultural staples. The grain and beef of Illinois sent abroad represents just so much of the stored fertility of the Mississippi valley. Its price is determined by competition with the products of the Argentine, of Russia and of India.

Contrast now with the exports of this class those of another class, the articles in whose production brains and labor cut the chief figure. Such exports as typewriters and guns, sewing machines and watches, shoes and cloth, locomotives and bicycles. The profit on such goods is far above that on the great staples of commerce. A firm or a nation which builds up a reputation by the production and sale of such goods has a hold on its trade that is never secured by the producer of raw materials.

This comparison, it may be noted, is just as true of domestic trade as of international trade. Coal and ore are typical raw materials. Contrast the condition of a typical community in a coal mining region with such a city of highly developed manufactures as Dayton, Providence, Springfield or Bridgeport. The blast furnace building boom in the South a decade ago brought disappointment to those who expected rapid growth in population and wealth. They found that pig iron production gives employment to a comparatively small amount of labor and at low wages. It is the new cotton mills and the diversified productions of a thousand small factories that are laying sure foundations for general prosperity in the South.

Another thing is to be noted in comparing the production of raw materials with the production of goods whose manufacture requires large labor expenditure. The chief beneficiary from the production and export of minerals is the capitalists, and it may often happen that he is a non-resident, so that the only benefit the exporting nation may gain is the employment of a small amount of low-priced labor. How much benefit have Spain, or Cuba, or Algeria reaped from their exports of iron ore? For the production of manufactured goods, on the other hand, labor must be employed; and the more highly developed the manufacture, the greater may be considered the resultant benefit to the community or the nation which sells such goods.

If these principles be accepted as sound, their application to present commercial conditions must be evident. Mr. Garrett advises the owners of British rolling mills to buy steel billets from the United States and use them as raw material from which to turn out more highly finished products. The advice is unquestionably good; but from the point of view of American interests, it is better by far for us to send our iron and steel abroad in more highly finished forms. It is better for us to export plates than billets, and better still to send bridges and boilers and ships than plates.

Mr. Garrett well describes the superiority of American rolling mill practice; but he does not refer to the fact that the great bulk of the rolling mills of the country, including those best fitted to engage in international trade, are under the control of a single huge corporation. If this corporation continues the policy of selling at reduced prices to the foreign purchaser while maintaining a higher price to the home consumer, the tendency will be to increase our exports of rolling mill products at the expense of our export of more highly finished goods. It may be said that in some of its departments, such as bridges, wire and tin plate, the United States Steel Corporation itself turns out its product in a highly finished state. Admitting the truth of this, it is nevertheless the case that its products form the raw material for hundreds of small manufactures, and that a discrimination against them in favor of their foreign competitors is an unwise and injurious handicap to a most important and valuable part of our export trade. This is not a theoretical view of the case by any means. It is the practical condition which is now confronting manufacturers in a hundred lines; and the demand for relief from it is insistent.

A short time ago we discussed in this place the inevitable exhaustion of nature's stores of raw material, and showed that one of the greatest problems before the engineer of the present century will be to conserve the earth's stores of raw materials to meet the demands of its growing population.

This problem is bound to become more and more pressing with each passing year. It will exert a greater and greater influence in determining the fiscal policies of nations. If the present era of international competition continues, we shall undoubtedly see the export of raw materials restricted by a tariff. Indeed, a notable step in this direction has already been taken by Great Britain in placing a duty on exported coal. Strong as is the opposition which this tax has met, its wisdom as a piece of far-seeing statesmanship is sure to be vindicated with advancing years.

We do not by any means advocate, however, the increase of restrictions upon international trade; instead we would favor the removal of such barriers and of the conditions which now operate, in too many cases, to foster our exports of raw materials at the expense of more highly-finished products.

So much has been said regarding the growth of American export trade during the past few years, that the public has gained a somewhat erroneous impression regarding it. It seems to be thought that the supremacy in nearly all branches of manufactured products has already been won by Americans. A study of the statistics of our export trade and of that of other nations show the falsity of this idea. The great bulk of our exports are still raw materials, or goods in a more or less crude state. In the engineering industries we have indeed won an enviable position; but in the textile industry, the chemical industry, and in numerous other fields the American manufacturer still has much to do to place himself on a footing with his foreign rival.

We may rightly and patriotically rejoice over such victories for American skill and industry and enterprise as those which Mr. Garrett so well describes; but let us temper our rejoicings with modesty, remembering that a comparison of American with foreign products and methods in some other fields, might not be so gratifying. The world may yet be ours; but notwithstanding the success of our endeavors in capturing a part, we have not yet won the whole by any means.

LETTERS TO THE EDITOR.

The Economics of Highway Improvement.

Sir: I am aware that beyond a certain point argument becomes wearisome to all but those directly engaged. Upon the economic feature of hard roads so little has appeared as yet that it would seem that something might still be said without repetition. If you will grant me space I should like to reply to Prof. Baker's criticism of my letter that appeared in your issue of April 11th. Relative to the weight of crops, the fact that Professor Baker and I live in quite different sections of the country may account for some of our differences. The estimate of weight of crops I have taken from local farmers in an exceptionally fertile district; but as I tabulated the weights more for the sake of comparison than for absolute accuracy, I do not see the point of Professor Baker's attack.

Regarding the little problems in which I assumed 1¼ tons raised per acre, I am right for this district, and I find that Mr. Budd in his Fifth Annual Report on the New Jersey highways gives an equal weight of crop per acre.

Professor Baker found by writing 316 Illinois farmers that the average per diem cost of a team and driver is $2.13, while my own experience and that of many others is that $3 is nearer the actual cost. How did Professor Baker's farmers arrive at their results? One at least whom he regards as an authority, he quotes as saying that nothing should be charged for interest and depreciation of team and wagon. Engineers will doubt the credibility of any such witness. It takes a trained observer employing men who keep a careful record of the food consumed, the useful life of animals, harness and wagon to give a satisfactory answer to questions of cost. The farmer who keeps such records is "a rare bird."

I find that where careful observations have been made the per diem cost of team and driver is far in excess of $2.13. The Brooklyn City R. R. Co. employed about 2,000 horses a generation ago, with a monthly feed bill of $10 per horse. The average annual depreciation for a term of years being about 25%." Such a depreciation is unquestionably greater than a farm horse suffers, but he is untrustworthy who says that depreciation is insignificant. Having estimated the total cost of team and driver per annum, the next question is by what number have Professor Baker's farmers divided the total to get the daily cost. Judged by the results, I should say the number used was 300, which is equivalent to allowing nothing for lost time, whereas it has been my experience that 200 is more nearly an average in the Northern states.

Far be it from me to berate the farmer. He knows his business, but the economic details he has not always considered a part of his business. For example, I fancy it would be hard for him to tell you what it has cost him to raise a certain calf that he is about to sell. He may know its market value, but of actual cost he knows little. If farmers are the best judges of road economics, how does it happen that the farmers who sent delegations to fight the good roads law of New Jersey are now falling over one another to get hard roads built under that very law? The fact is that what they feared was not the failure of hard roads as money savers, but they feared the payment of taxes in money instead of in labor, for money is always a scarce article with the farmer. This fear has quickly died out when they found that the contractor had to employ farmers and their teams to build the roads and in that way furnished them with the cash to pay their taxes. Where the state at large bears part of the road-tax burden, as it should, the farmers actually receive more money for the road construction than they afterward pay out in taxes. Yours truly,

Halbert Powers Gillette.
791 Powers Block, Rochester, N. Y., May 4, 1901.

Steel Framing for Freight Cars.

Sir: The articles under the above heading in Engineering News of March 28 and April 18 were of much interest to me. I believe that a steel car should be framed quite differently from wooden cars in order to get the full value of the stronger material. Mr. Henderson in his comment (p. 296, Eng. News, April 18), touched a very important point.

With steel construction, the longitudinal members being of steel, there does not seem to be any elasticity to take up the shock, as in the case of the wooden car.

Suppose we leave out the center beams altogether and transmit the horizontal forces from the drawbar through a horizontal girder to the sides of the car and through the car sides as compression or tension members to the other end of the car, will not greater elasticity be obtained? Why put rigid direct columns through from drawbar to drawbar and then spend so much money for springs to destroy this rigidity?

In leaving out the center sills, floor beams extending from side to side are required and the car sides must be strong enough to carry the entire load. The writer has seen both wooden and steel gondola cars loaded with I-beams and channel 60 to 70 ft. long, requiring two cars, and the load was applied on the top of the car sides midway between the bolsters, this load of half the car's rated capacity concentrated at the center of the car sides requires a girder at each side of the car capable of carrying half of the entire load. Such loading is common between Pittsburg and Chicago. Since the material must be in the sides to carry the load, why not arrange to have it do it under all conditions of loading?

I do not agree with Mr. Scott in having "a system of underframing competent to carry the whole of the dead and applied loads without assistance from any associated upper structure." In the case of a steel gondola car having side girders 4 to 5 ft. deep attached rigidly to the underframing, it is an impossibility to have the underframing carry the load, and in a car with center sills the deflection of the comparatively shallow sill is so great that it cannot carry its assumed part of the load.

With regard to the strength of a bolster required for a car having no center sills, I can see no serious objection to its increased weight when it can be shown that with such construction the total weight of the car is very much reduced.

The writer has designed a flat-bottomed steel gondola car with a rated capacity of 100,000 lbs. of coal. In proportioning the parts 100,000 lbs. plus 10% is considered as uniformly distributed over the entire floor, to this is added the dead weight of the car body and the whole is increased by 50% for proportioning all parts of the body except the body bolster and by 100% for the body bolster. To this is added the stresses due to a buffing or tugging load at the drawheads of 120,000 lbs. For soft steel in tension a unit stress of 16,400 lbs. per sq. in. is allowed.

A comparison of the weight of this car with some others may be of interest. In the following the net weight of the body alone is considered, the trucks, drawheads and springs, and the brake mechanism are assumed to be the same in all cases:

Name of Car.	Size of body, inside measurement.	Weight, lbs.	Cu. capacity, level full cu. ft.
The E. W. Summers.. Pressed shapes ..... Inside stakes....	38'0" long 10'0" wide 4'0" high	17,300	1,520
Pressed Steel Car Co.. Pressed shapes	41'9" long 9'3½" wide 4'0" high	20,400	1,550
Amer. Car & Fdy Co.. Structural shapes ..	40'0" long 9'6" wide 4'0" high	22,200	1,520

The E. W. Summers car and the Am. Car & Fdy. Co. car were designed with the same unit stresses and the same

loading, except that for the A. C. & Fdy. Co. car, the live load of 100,000 lbs. was increased by 20% instead of by 10%.

The argument that steel cars should be built of ordinary structural shapes in order that repairs can be made in any part of the country seems to me unsound. With a difference of 2,000 to 4,000 lbs. in favor of the car made of special shapes, and the saving in the cost of hauling, the lighter car will more than pay for all the repairs on it. Patents have been taken out on these designs.

Yours truly, E. W. Summers,

Akron, O., April 24, 1901.

Bascule Bridges Over the Chicago River.

Sir: In Engineering News, April 25, 1901 (p. 311), is an article entitled "Page Bascule Bridge over the Chicago River at Ashland Avenue." This article contains several statements from which it might be inferred that the Scherzer rolling-lift bridge has been superseded by the trunnion type or fixed center system of bridge, as the article states: "All the bascule bridges already built over the Chicago River are on the Scherzer rolling-lift system, but several of the new bridges are on the fixed-center system." This statement does not entirely conform to the facts, as a bascule bridge of the Harmon type, with a fixed-center system, had been in existence at Canal St., Chicago, for about eight years, and is now being replaced by a Scherzer rolling-lift bridge. Another bridge of the Harmon type existed at Weed St. for about ten years.

Although several trunnion bridges or bridges on the fixed-center system are about to be constructed at Chicago, the Scherzer rolling-lift bridge has not been entirely superseded. Bridges of the Scherzer type are in process of construction across the Chicago River at Canal and Main Sts., and a railway bridge near Taylor St. Plans have also been completed by the Scherzer Rolling-Lift Bridge Co. for new bridges at Harrison St., State St., Randolph St. and 18th St., and within a few weeks plans will also be completed for a new rolling-lift bridge at Polk St., all to cross the Chicago River at Chicago. All of these plans have been prepared under contracts with the Sanitary District of Chicago, which provide not only for the making of the plans, but also for the supervision of construction, and construction will be commenced as soon as the contracts can be let.

The article above mentioned contains the statement: "We are informed that an analysis of the bids on this and other designs for a bascule bridge show that the Page design is economical in material and in cost." If this comparison of material and cost has any reference whatever to the Scherzer rolling-lift bridge it ignores the facts forcibly presented by the bids received by the Sanitary District of Chicago on Jan. 16, 1901, for the construction of the Page bridge across the Chicago River at Ashland Ave., above mentioned, and the bids received by the Sanitary District of Chicago on the same day for the construction of a Scherzer rolling-lift bridge at Main St., also across the Chicago River. Both bridges were designed under the same specifications; they also provided for the same width of clear waterway, and the same width of roadway and sidewalks, but there was a vital difference between the forms of the two structures. The Page design was for a through bridge with overhead construction, machinery and counterweight; the portal, when the bridge is opened, comes within a few feet of the roadway, thus endangering the traffic crossing the bridge. The form of truss was necessitated by the type of bridge, and is contrary to the usually accepted form of artistic bridges in metropolitan cities. The lowest bid for the superstructure, under which the contract was let, was $91,200. The lowest bid for the superstructure of the Main St. Scherzer bridge, under which the contract was let to the American Bridge Co., was $72,800. The form of the Scherzer rolling-lift bridge was not selected wholly for economy, but it was also selected for the purpose of securing graceful and artistic outlines, and insuring the safety of the traffic crossing the bridge. It is not a through span, but is a half-through span, without any overhead construction, overhead counterweight, machinery, portals, or bracing, which might be dangerous to traffic when the bridge is opened. The outlines of the rolling-lift bridge provide for an arched bottom chord, which is the accepted form in all artistic bridge structures, both ancient and modern. Yet the superstructure of this bridge costs $18,400 less than the superstructure of the Page bridge. It is true that the bid for the substructure of the Scherzer bridge was somewhat higher than the bid for the substructure of the Page bridge, but the total cost of the Scherzer bridge, even with the larger substructure (necessitated by the selection of the arch design and deck bridge), was about $6,000 less than the total cost of the Page bridge. Had the Scherzer bridge been designed as a through bridge, similar to the Page design, the superstructure would have cost still less than it did for the arch span, and the substructure would also have cost less than the substructure of the Page bridge, because the Scherzer rolling-lift bridge would have less structural steel and about 200 tons less counterweight, and also less machinery to support. The by-passes, if they had been considered necessary, would have been as large or larger than the by-passes provided by the Page bridge. A through bridge of the Scherzer type would not be an experiment, and its cost is well determined, for many of them are now in use for railway purposes, where the slight elevation of the base of rail above water compels the use of a through bridge. The overhead portal coming down when the bridge is opened is not objectionable in a railway bridge because trains are stopped at some distance from the portals by automatic signals. Had a through type of Scherzer rolling-lift bridge been used at Ashland Ave. in place of the Page bridge above mentioned, the saving in cost of construction would have been about $23,000.

The total cost of the two bridges, according to the bids under which the contracts of construction were let by the Sanitary District of Chicago, would be as follows:

Page Through-Truss Bridge at Ashland Ave.: Superstructure, $91,200; substructure, $35,542; total, $126.742. Scherzer Arch-Deck Rolling-Lift Bridge at Main St.: Superstructure, $72,800; substructure, $47,588; total, $120,388; additional saving in superstructure and substructure, had a through-truss Scherzer rolling-lift bridge been used in place of the arch-deck form, at least $17,000; total cost of construction of a Scherzer rolling-lift through bridge, similar in size, capacity and outline to the through Page bridge at Ashland Ave., $103,388; cost of through-span Page bridge greater than cost of similar Scherzer rolling-lift bridge, $23,354.

As the Scherzer rolling-lift bridge has less resistance from friction than any fixed-center trunnion bridge, the cost of operation and maintenance must necessarily be much less for the Scherzer rolling-lift bridge than for the Page bridge.

As no Page bridge has ever been constructed, its certainty of successful operation has not yet been demonstrated, as has been the certainty of successful operation of the Scherzer rolling-lift bridge.

In the article in question the following claim is also made: "One great advantage which the Page design is claimed to possess over any other design submitted to the Sanitary District, particularly for the Chicago River, is the width of clear waterway. For a distance of 200 ft. between dock lines, this width is said to be 20% greater than in any other design, and with a wider distance this percentage would increase proportionately." No bridge of the Page design has ever been constructed and the design of deck bridge which is shown on p. 312 only provides for a clear waterway 92 ft. wide, with two by-passes, each approximately 20 ft. wide. The least waterway now required by the Sanitary District of Chicago is 140 ft. wide between protections. What the size of the piers would be to support the superstructure, counterweight and machinery of a deck Page bridge of such a span is not shown, nor is the cost of the structure given. The Scherzer rolling-lift bridge can be (and has been) designed, built and successfully operated, so that no part of the superstructure comes below the water line when the bridge is opened. The Scherzer bridge can give a wider percentage of clear waterway and waterflow than the Page bridge, and at less cost. The Scherzer bridge has no difficult or complicated shop work, the shop work for both the structural steel and machinery steel being exceedingly simple.

If the claim as to the economy of material, width of waterway and cost of the Page bridge was not based upon a comparison with the Scherzer rolling-lift bridge, for which bids were received upon the same day, but upon the cost, etc., of the bascule bridge being constructed over the Chicago River at Clybourn Place, Chicago, illustrated and described in Engineering News, Jan. 31, 1901 (p. 75), then the claims for the Page bridge appear to be well founded, for the type of trusses selected in both designs are similar, they both being through bridges. But the Clybourn Place bridge provides for a clear waterway only 100 ft. wide, in place of the 140 ft. clear waterway provided by both the Ashland Ave. bridge of the Page type and the Main St. bridge of the Scherzer type. The by-passes provided by the Clybourn Place bridge are exceedingly small, and may well justify the claim of larger by-passes provided by the Page bridge. The substructure of the Clybourn Place bridge was described in Engineering News, Jan. 17, 1901 (p. 56). The total cost of the superstructure of the Clybourn Place bridge, according to the reports of the bids under which the contract was let, was $84,000. The total cost of the substructure, under which the contract was let, according to the reports, was $63,486, making the total cost of the bridge $147,486, exclusive of the cost of plans, etc. Had the clear waterway provided been 140 ft. wide instead of 100 ft. wide, the proportionate cost would have been at least $100,000 additional. As the Page bridge spans a much larger clear waterway, the economy of the Page bridge compared with the Clybourn Place design would at once be apparent, but the above actual bids, under which contracts have been let, under similar market conditions, demonstrate that the Scherzer rolling-lift bridge is very much more economical than either of the other types of bridges above mentioned, and that if economy of metal, economy of construction, economy of maintenance, certainty of successful operation and width of waterway to be spanned control in the selection of the type of bridge, the Scherzer rolling-lift bridge merits the success which it has attained, and is not likely to be superseded in the immediate future.

I make the above statements because I am convinced that your journal is only desirous of presenting the exact truth to its readers, and will do equal justice to all interested parties. Yours very truly, Albert H. Scherzer,

President The Scherzer Rolling-Lift Bridge Co.

1616 Monadnock Block, Chicago, May 1, 1901.

(Our columns are always open for discussions of articles published, but we do not think any of our readers will have inferred from the article in question that the Scherzer type of bridge is being superseded in Chicago, as we have published from time to time notes of the new bridges of this type and of contracts awarded for their construction. The statements made above, however, will effectually dispose of any such inference.

The Weed St. and Canal St. bridges referred to are not exactly comparable with the other bridges mentioned, and in the list of Chicago River bridges given in the article on the Clybourn Palace bridge in our issue of Jan. 31, they were separately classed as folding bridges. These bridges have been described and illustrated in our columns—1891, I., 486; 1893, II., 480.

That the overhead bracing of a bridge comes close to the roadway when the span is opened is hardly an objection, as traffic should be stopped before the bridge is moved. The objection to any design of bridge on account of its being new and untried, would, of course, apply equally to every design of bridge in the early stage of its development. In regard to the Page deck bridge, the design shown was not prepared for the Chicago River, so that its narrow width of waterway has no special bearing upon the discussion of Chicago River bridges.—Ed.)

Notes and Queries.

Will the correspondent who sent us a letter regarding the relative merits of transits and levels for "plunging a grade" send us a duplicate of his letter? It has been mislaid since its receipt.

A LARGE INDUCED DRAFT FAN has been installed by the Buffalo Ry. Co. at its new power house near the Pan-American Exposition grounds. This plant will be used for furnishing power to the street railway lines during the exposition period and will be of 3,000 HP. nominal capacity. The fan, which is being built by the Buffalo Forge Co., of Buffalo, N. Y., is 24 ft. in diameter and of the up-blast type, with an inlet 9 ft. in diameter. It will be used as an exhauster and will be driven by a 13 × 12-in. horizontal steam engine. In order to keep the bearings cool, a constant circulation of water will be maintained around them. The short stack into which the fan will discharge will be constructed of sheet steel.

THE FINAL AND CONCLUSIVE DECISION of referees, named in a contract for public work, is denied by Judge Lawrence, of the New York Supreme Court, in a recent decision in the case of the National Contracting Co. vs. the Hudson River Water Power Co., to recover $615,548.32 as damages for the breach of a contract for the building of a dam across the Hudson River at Spier Falls. The defendant claimed that the plaintiff failed to obtain a decision under a clause in the contract which provided that "to prevent all disputes and litigation" it was agreed between the parties to the contract that the engineers of the work named, or their successors, should be referees to determine all questions of difference, and they were to fix the amount and quality of the work to be done under the contract, and "the finding, estimates and decisions of said engineers, or either of them, shall be final and conclusive." The plaintiff held that the clause in question ousts the court of jurisdiction, and is void by public policy, and Judge Lawrence sustains this demurrer, and says that the object of this provision in the contract is clearly to make the engineers the absolute and final arbiters as to all questions arising between the parties.

STEEL RAIL MAKING IN AUSTRALIA is to be encouraged by the government inviting tenders for 10,000 tons of steel rails, to be manufactured in New South Wales within four years. The government, however, also stipulates that these rails shall not cost more than they do in America or Great Britain, plus the freight charges.

A TRANS-AUSTRALIAN RAILWAY is being projected by the government of Australia, requiring an East and West railway about 1,000 miles long, connecting Kalgoorlie, in the Westralian gold fields, with Port Augusta, the western terminus of the South Australian railway system. The estimated cost is $12,500,000 as a maximum figure. The route would be over a level table land presenting no serious engineering difficulties for a standard gage road. In the transport of mails alone such a road would save three days in time, and it would open up enormous tracts of new country to the agriculturalist and miner.

UNEXPLORED CANADIAN TERRITORY, says the Director of the Canadian Geological Survey, in his last report, amounts to more than 1,250,000 square miles, out of a computed entire area of 3,450,257 square miles for the whole Dominion. Exclusive of the inhospitable detached arctic regions, 954,000 square miles are entirely unknown. Included in this unexplored area is almost the entire interior of the Labrador Peninsula, covering 289,000 square miles.

THE HARRELL STEEL-CONCRETE tie was described in our issue of Jan. 10, 1901, and as a result of the experience with 30 test ties a modified form has been designed. The bolt fastenings were not successful, as they worked loose and caused the disintegration of the concrete under the rails. In the new design a ¼-in. steel plate 7 ins. deep and 7 ft. 8 ins. long forms the core of the tie, being set on edge and having numerous perforations to form projecting lugs which will bond with the concrete. The ends are also bent over for the same purpose. Each rail seat is a ⅜-in. plate 14 ins. long and 5 ins. wide, resting on top of the long plate. Two straps riveted to the long plate pass up through this rail seat, and have holes for keys driven parallel with the rail. Spring clamps fit over the tops of the straps and are secured by the keys. The concrete is a wet mixture of Portland cement and ⅝-in. crushed limestone. The finished tie is 8 ft. long and 8½ ins. deep. For about a third of the length (at the middle) the width is 5 ins. at top and bottom; but at the ends this increases to about 6 ins. at the top and 9 ins. at the bottom.

THE CENTER OF POPULATION OF THE UNITED States, says the Census Office, is now in Southern Indiana, about six miles southeast of Columbus. In 1790 this center was about 33 miles east of Baltimore; and in the last 110 years it has moved westward 519 miles. In the decade 1890-1900, however, it only moved about 14 miles westward and 3 miles southward. The center of area of the United States, excluding Alaska, is in Northern Kansas. This center of population keeps remarkably close to the 39th parallel of latitude, the extreme variation from this line, in 110 years, has been only 19 minutes, while the movement in longitude is a little over 9.5°.

A GERMAN-ENGLISH-FRENCH TECHNICAL DICtionary is in course of compilation by the German Society of Engineers. For this purpose the society is asking the co-operation of the technical societies of all nations and that of industrial establishments of all kinds. The dictionary is to be arranged alphabetically in three divisions, each representing one of the languages named; and the expectation is that a dictionary will be produced that is thoroughly up to date. The editor-in-chief is Dr. Hubert Jansen.

A SIXTEEN-WHEEL TANK LOCOMOTIVE has been built for the government railways of Natal, South Africa, by Dubs & Co., of Glasgow, Scotland. It has ten driving wheels (the second pair being the main drivers), a four-wheel leading truck and a single pair of trailing wheels under the cab and rear coal bunker. The cylinders are outside and inclined, with "alligator" crossheads. The boiler is of the straight-top type, with side tanks extending nearly its entire length, while the semi-enclosed steel cab has a coal bunker in the rear. The weight is 158,844 lbs., but tank engines on the Indian State Rys. (5 ft. 6 ins. gage) weigh 206,276 lbs. These Indian engines have eight driving wheels and single leading and trailing wheels. The principal dimensions of the Natal engines are as follows:

Gage of track	3 ft. 6 ins.	
Driving wheels	3 " 9 "	
Truck wheels	2 " 1⅛ "	
Wheelbase, total	30 " 6 "	
Weight, total	158,844 lbs.	
Cylinders	19 × 27 ins.	
Heating surface, tubes	1,358.75 sq. ft.	
" " firebox	149.00 " "	
" " total	1,507.75 " "	
Grate area	21.15 " "	
Capacity of bunker	160 cu. ft.	
Capacity of side tanks	1,720 gallons	

ANOTHER STREAM POLLUTION SUIT IN INDIANA is reported. This one was brought against the Muncie Pulp Co. by Chas. Minnick. Damages of $6,000 are asked, as well as an injunction against the further pollution of Buck Creek.

A CONVERTIBLE CAR FOR SUMMER AND WINTER USE.

Two distinct types of cars, open for summer and closed for winter service, are in use on most American street railways. The cost of the duplication of rolling stock has led to many designs for "convertible" cars, or cars which can be changed from the closed to the open type, or vice versa, with the changes of season. Notwithstanding the manifest advantages of such cars, they have never found general favor. A modification of the convertible car, termed the "semi-convertible," is much more generally used. This type of car is designed on the idea that it can be made sufficiently open for comfort in warm weather by simply removing the sashes and blinds, leaving solid framed sides, which, however, are somewhat lower than in the ordinary closed cars. There are no side entrances, the cars having the ordinary end platforms and vestibules.

The accompanying illustrations represent a new design of car of the "semi-convertible" type, which is being adopted by several high-speed electric railways and is also being advocated for use in the local and suburban service of steam railways. Fig. 1 is an exterior view of one of these cars, with sashes removed for summer service. Fig. 2 is an interior view, showing the curved guides for the sliding sashes. The seats, it will be noted, are arranged as in ordinary steam railway cars.

The framing is slightly lighter than in ordinary cars, the reduction of weight being effected by improvement in design. The sides are considerably lower than usual, and can be made either straight or curved, as desired, but in either case a truss plank bolted to both posts and sills is employed, as in steam car practice. The posts are double, glued together, with a tie rod between the parts. In the roof construction, the lower carlines, the heads of the posts, the rail and the letter board are so combined as to afford exceptional strength; the area of the letter board and rail (both halved upon the posts and carlines) being nearly equal to that of the sill. The interior construction gives an increased clear width of 6 ins., of which 3 ins. is given to the center aisle.

The sashes, which are larger than usual, are double, and are so arranged that when it is desired to make an open car, the sashes slide upward on trunnions running in grooved guides. They fit into pockets formed between the roof boards and the lining, where they are out of sight and out of the way. The general form and appearance of the roof do not differ much from the ordinary car, as may be seen from the accompanying views. This arrangement for storing the sashes is claimed to be a valuable feature. It does away entirely with the expense of taking out the sashes and storing them at the car barn, and the liability of breakage in thus handling them, which is an objection to most convertible cars. Another objection to the entire removal of the sashes is that the car must be run as an open car until the close of the summer, the time and expense of changing being too great to permit of intermediate changes. In the cars herewith illustrated, however, the conductor can lower all the sashes in a few minutes, and thus convert the car to a closed car in case of storm or a period of cold weather.

This type of car is the invention of Mr. John A. Brill, of the J. G. Brill Co., Philadelphia, Pa., to whom we are indebted for photographs and information. The design has been patented in the United States and several foreign countries. Mr. Brill makes special claims for the use of these cars in the local and suburban service of steam railways, on account of their convenience and comfort, and the fact that their light weight enables a prompt acceleration to be made in service requiring numerous stops, without requiring the use of very heavy engines.

Fig. 1. Exterior View.

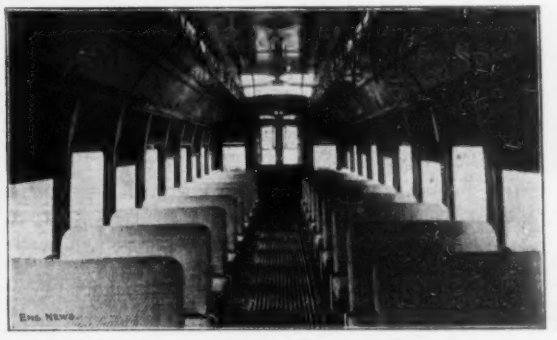


Fig. 2. Interior View.

A CONVERTIBLE CAR FOR SUMMER AND WINTER SERVICE. The J. G. Brill Co., Philadelphia, Pa., Builders.

STORIES FROM THE RAILWAY SERVICE.*

The daily routine of a great railway embraces everything from the pathetic to the ludicrous, from deeds of sublime heroism to cheating and fraud of every description. A few instances may be of interest to you:

A collision occurred, due either to the fault of the telegraph operator at a signal tower or to the fault of the crew of the train. The engineer, conductor and train crew, numbering five or six men, stated positively that signals had been given them as the rules required. Against these five or six statements was only the word of a young boy, who was operator in the signal tower at a distant and remote point in the mountains; yet on account of various small matters, such as telegrams to the dispatcher, immediately before the accident, and words dropped by members of the train crew in conversation the management of the road was constrained to decide that the operator was telling the truth and that the train crew were lying. There was not another human being that saw the accident except the crew involved and this young operator; and yet it was proved and afterwards admitted that he and he alone had told the truth and the whole truth about the matter, which goes to show that the old saying that "truth is mighty and will prevail" applies to the everyday practical working of railways as it does to every other form of human labor in this world.

The following remarkable case was tried in North Carolina. A man was walking along a railroad track on his way to a turkey blind, with a double-barrel shot gun, loaded with turkey shot. A fast express train came along, and the man stepped to one side. A little scrub North Carolina bull at the same time stepped on the track, and the engine struck the bull and threw him twenty or thirty feet, hitting the man and knocking him into a pond of water, which saved his life. His gun was thrown from his hands and discharged, killing one cow and fatally wounding another. Result: The man sued the railway company for damages for being hit by the bull, claiming that the railroad company had negligently and carelessly thrown a bull at him, doing him serious bodily injury. The owner of the cows sued the man for killing his cows. The court decided that the railroad company could not be held to have anticipated such an accident, and therefore decided that case in favor of the railroad company, but decided that the owner of the cows could recover $100 for the loss of the cattle.

Another remarkable case: As a passenger train was passing over a bridge two Pullman cars jumped the track on a curve and went off into the river, falling 25 or 30 ft. The river was very high on account of a freshet, and the trucks, of course, dropped from the cars. The water came in very slowly on account of the double windows and tight doors, so the cars floated several hundred feet down the river, gradually filling with water. The men broke out through the ventilators at the top of the car and were able, with assistance from shore, to rescue the passengers. It was very early in the morning, before the passengers had gotten up, and a gentleman who was on the train stated that when the car was nearly filled

*From an address by L. E. Johnson, General Manager Norfolk & Western R. R., to the students of Purdue University.

with water he observed two ladies, who had been unable to get any clothes except what they were sleeping in, hanging by the rod which supports the curtain of the berths, and that these two ladies had their hair up in curl papers, and the water was nearly to their armpits. When they were rescued it was found that they had gotten the papers out of their hair, which was nicely arranged. In other words, they had managed to swing with one hand and with the other take out the curlpapers—showing that with the gentler sex vanity is superior even to the fear of death, and that they, at least, proposed to look well when drowned.

Amongst the passengers was one man who was very active in aiding the company in resisting claims for losses of baggage, etc., there having, of course, been many claims put in for enormous amounts. This man apparently was doing everything possible to aid the company, and one day was asked what he had lost. He said he had a satchel which contained a good many clothes, including a good deal of silk underwear. For this, however, he made no claim, being glad enough to get off with his life, but he said he had a new watch and some jewelry which he had bought to the value of about $250, for which he would like to be paid at the company's convenience. He had been so helpful, energetic and active that he was immediately given his $250. When the river went down and the car was brought up this man's satchel was found. Its contents consisted of a shirt, a pair of socks, two collars, a pair of cuffs and a half bottle of whiskey. It is supposed that it was the whiskey which he considered to be his jewelry.

TEN-WHEEL PASSENGER ENGINES; SOUTHERN PACIFIC RY.

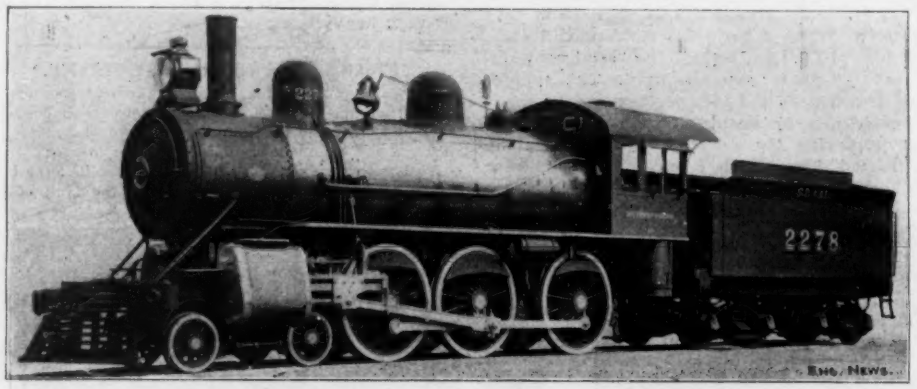
The locomotive equipment of the Pacific System of the Southern Pacific Ry. has recently been increased by the addition of eight passenger engines of the ten-wheel type, intended for hauling the heavy through passenger trains. One of these engines is shown in the accompanying cut. The engines are non-compounds, with cylinders of rather exceptional length of stroke, 28 ins., and are fitted with piston valves, which are coming into increasing favor for large simple engines. The guides are of the Laird type, and all the rods are of I-section, with solid ends to the coupling rods. The valve rods are very short, the rockers being in front of the leading driving axle. It will be noted that the engine is fitted with truck brakes, so that every wheel of the engine and tender is available for braking power.

The boiler is of the extended wagon-top type, with the sand box (fitted with air-jet device) close to the smokebox, and the dome and safety-valve fittings on the wagon top. The firebox (for bituminous coal) is of the radial-stay type, with firebrick arch (but no water tubes for the arch), and is placed above the frames, with a drop at the front end. The cab is of steel plate construction, extending back beyond the boiler head, and the main air reservoir is placed vertically under the left-hand side of the cab. The tender has a steel frame and is mounted on a pair of diamond frame trucks. Both engine and tender are fitted with M. C. B. couplers.

The engines were built to the general designs of Mr. H. J. Small, Superintendent of Motive Power, Southern Pacific Ry. (Pacific System), of Sacramento, Cal., by the Cooke Locomotive & Machine Co., of Paterson, N. J. We are indebted to Mr. Small and to the builders for particulars of these engines, the dimensions of which are given below in our standard form:

TEN-WHEEL PASSENGER LOCOMOTIVE; SOUTHERN PACIFIC RY.

RUNNING GEAR:	
Driving wheels (6), diameter	5 ft. 9 ins.
Truck wheels (4), diameter	2 " 6 "
Tender wheels (8), diameter	2 " 9 "
Driving wheel centers	Cast steel.
Truck and tender wheels	Steel tired.
Driving wheel tires secured?	By shrinkage.
Engine truck	Swing center.
Journals, driving axles	9 × 11¾ ins.
WHEELBASE: Driving, 13 ft. 8 ins.; Truck..	6 ft. 2 "
Total engine	24 " 6 "
Tender	17 ft.; Engine and tender 52 " 2 "
Engine truck-pin to c. leading driving wheel	7 " 9 "
Wheels having blind tires	None.



TEN-WHEEL PASSENGER LOCOMOTIVE; SOUTHERN PACIFIC RY.

H. J. Small, Superintendent of Motive Power, Sacramento, Cal.; Cooke Locomotive & Machine Co., Paterson, N. J., Builders.

WEIGHT IN WORKING ORDER:	
On driving wheels	130,000 lbs.
On truck wheels	36,000 "
Engine, total	166,000 "
Tender, empty..52,250 lbs.; loaded	122,250 "
Does counterbalance conform to M.M.Assoc. rules?	Yes.
Weight of piston and rod complete	359 lbs.
Crosshead	280 "
Main rod ..530 lbs.; side rods	656 "
CYLINDERS: Number	Two.
Diameter and stroke	20 × 28 ins.
Cubic contents of all cylinders	10.1 cu. ft.
Form of crosshead and guides	Laird.
Connecting rod, length c. to c.	9 ft. 4 ins.
Side rods	Solid ends.
VALVE GEAR: Type	Shifting link.
Ports: Steam..1¾ × 22 ins.; Exhaust	3¼ × 22 ins.
Bridges, width..2 " ; Eccentrics, throw..	5¾ "
Slide-valve, style ...Piston; Maximum travel	6 "
Inside clearance..$^{3}/_{32}$-in.; outside lap	1⅛ "
Lead (full forward and backward gear)	$^{1}/_{32}$-in.
Depth at front...6 " $^{7}/_{16}$; depth at back..5 "	5¾
Thickness,side plates..⅝-in.; back plate	⅝
Crown plate..⅝-in.; tube plate	½
Crown stays..Radial; Grate bars..Rocking fin	
Is fire-brick arch used?	
Stay bolts (drilled), diam., 1 in.; pitch	4½
Water spaces, width at front	4
At back and sides	3½
TUBES: Material..Steel; No.	
Thickness..0.125-in.; pitch	2⅜
Diameter, outside	
Length over tube plates	
Total area of tube openings	5.7 sq
HEATING SURFACE AND GRATE AREA:	
Heating surface, tubes (interior area)	2,048.83
" " firebox	173.67
" " total	2,222.50
Grate area	30.22
Ratio, total heatg. surf. to grate area	73.54
Interior tube area to firebox heat'g surface	11.8
Total heating surface to 1 cu.ft. cyl'd'r vol.	22.00
Firebox heatg. surf. to 1 cu. ft. of cyl. vol.	17.20
Tube heating surf. to 1 cu.ft. cylinder vol.	202.85
Grate area to 1 cu. ft. of cylinder volume..	2.99
MISCELLANEOUS:	
Exhaust nozzle, single; diameter	4⅝
Distance below center line of boiler	2
Smokestack, diam., top, 16 ins.; base	14
Height above smokebox	4 ft. 4½
Height of top above rail	15 " 8⅞
Capacity of tender tank	6,000 gallo
Of coal space	20,000 lbs
Brake fittings	Westinghouse-Americ
Total tractive force with effective pressure equal to 85% of boiler pressure	27,594 lbs

THE NEW WATER PURIFICATION WORKS OF THE EAST JERSEY WATER CO., AT LITTLE FALLS, N. J.

By Geo. W. Fuller, Assoc. M. Am. Soc. C. E.*

On March 7, 1901, bids were opened by the East Jersey Water Co. for the construction of a system of water purification works at Little Falls, N. J. The works (Fig. 1) are located just below the company's pumping station (described in Engineering News of Aug. 3, 1899), on the narrow strip of land between the Passaic River and the bluffs. The location is such with reference to the present works that a gravity flow will be obtained, from the head race canal leading to the pumping station, to and through the purification works and back to the suction of the pumps.

The filters in these purification works are designed to have a normal net capacity of 32,000,000 gallons daily; and, if need be, to yield 40,000,000 gallons daily during periods of heavy consumption. When the works are completed (specified as Dec. 15, 1901), they will supply filtered water to the cities of Paterson and Passaic, which together have an average daily water consumption of about 15,000,000 gallons.

Until the completion of the new works for Jersey City at Boonton, and the termination of the temporary contract which the East Jersey Water Co. has with Jersey City, a portion of the purification works will not be used. At the close of the Jersey City contract, filtered water from Little Falls will be supplied to several towns and water companies along the line of the conduit from Little Falls to Belleville. These consumers, Mont-

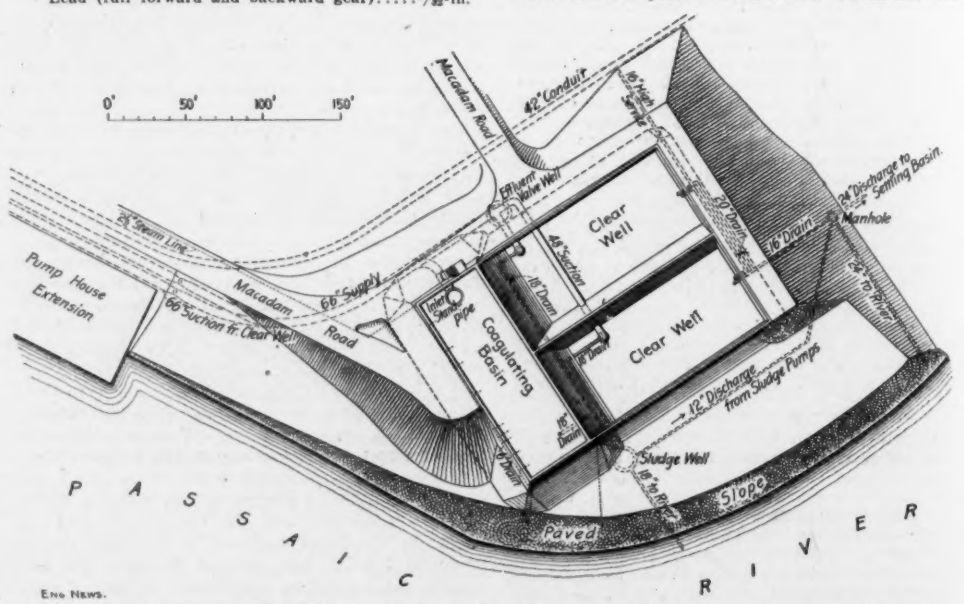


FIG. 1. GENERAL PLAN OF PURIFICATION WORKS OF THE EAST JERSEY WATER CO., AT LITTLE FALLS, N. J.

*Of Hering & Fuller, Consulting Engineers, 100 William St., New York city.

clair, West Orange, Glen Ridge, Franklin, Nutley, Harrison, Kearney and Bayonne, now use about 7,000,000 gallons daily.

These works are of the American or mechanical system, and were adopted upon the recommendation of the writer, who made a preliminary report on this subject in May, 1900. The decision to adopt this method of purification was based upon the great desirability in these communities of removing the high amount of color or vegetable stain which at times the Passaic water possesses; and, especially, upon grounds of economy. The conditions at Little Falls are rather unique in that the situation allows the construction of a mechanical plant to be operated by gravity, whereas a sand filter plant would involve the expense of an additional pumping station to elevate the water to a suitable filter site.

The water company, in June, 1900, asked the New York Filter Co. and the Continental Filter Co. to submit outline plans and general estimates of cost for this project. These were submitted to the water company in September, 1900, and were referred to the writer, who was requested to supervise for the water company the preparation of detailed plans by the filter company, and also to prepare specifications, according to the best available information. Mr. Chas. L. Parmelee, now Chief Engineer of the New York Continental Jewell Filtration Co.,* took charge of the development of the outline plans requested by the water company. In the construction features of the plans the writer was assisted by Mr. W. B. Fuller, M. Am. Soc. C. E., who is now the resident engineer, for the water company, in charge of the construction of the works. The entire project is under the general direction of Mr. J. Waldo Smith, M. Am. Soc. C. E., Chief Engineer and Superintendent of the East Jersey Water Co.

These purification works comprise the following principal parts:

(1) A covered coagulating basin (Figs. 2, 3 and 4) 44 ft. deep, having a capacity of about 1,700,000 gallons, equal to one hour's flow at the rate of 40,000,000 gallons daily, and provided with necessary piping connections and facilities for draining and cleaning.

(2) House over coagulating basin (Fig. 4) about 45 × 134 ft., in which will be located offices, laboratories, store room, devices for application of coagulants, and other mechanical appliances.

filters each (Figs. 2 and 3), located east of and adjoining the coagulating basin, and built above the clear water basin.

(4) Two pipe galleries, each about 12 ft. wide, 13.5 ft. high, placed between a double row of filters, and containing all main piping for connection with the filters on either side of it. The top of these galleries is at the same elevation as the top of the walls of the filter tanks. Over these pipe galleries are floors to serve as platforms from which the filters will be operated.

roof with a manhole for each filter, through which filtering materials can be delivered or removed.

(6) Clear water basin (Figs. 2 and 3) occupying the area beneath the filters, having a maximum depth of about 30 ft., and capacity of about 3,500,000 gallons, and separated by a dividing wall into two compartments.

The substructure is to be of concrete. The filters and superstructure (beginning at the maximum flow line in the clear water basin) will be of concrete and metal, after the Ransome system. No

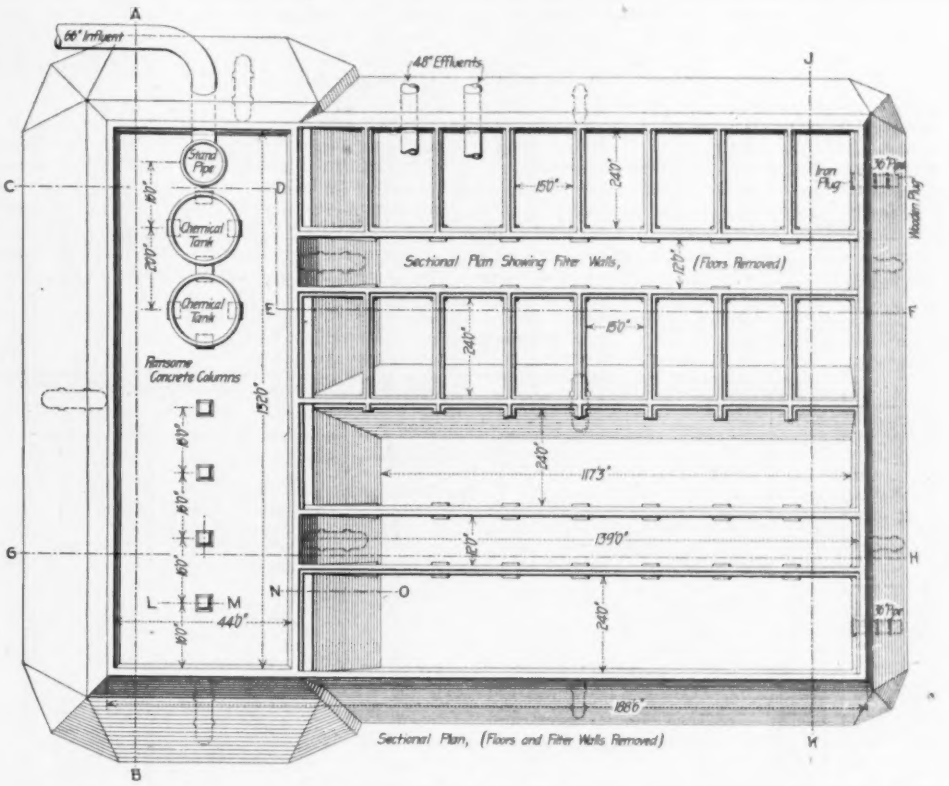


FIG. 2. SECTIONAL PLAN OF SUBSTRUCTURE, LITTLE FALLS WATER PURIFICATION WORKS.

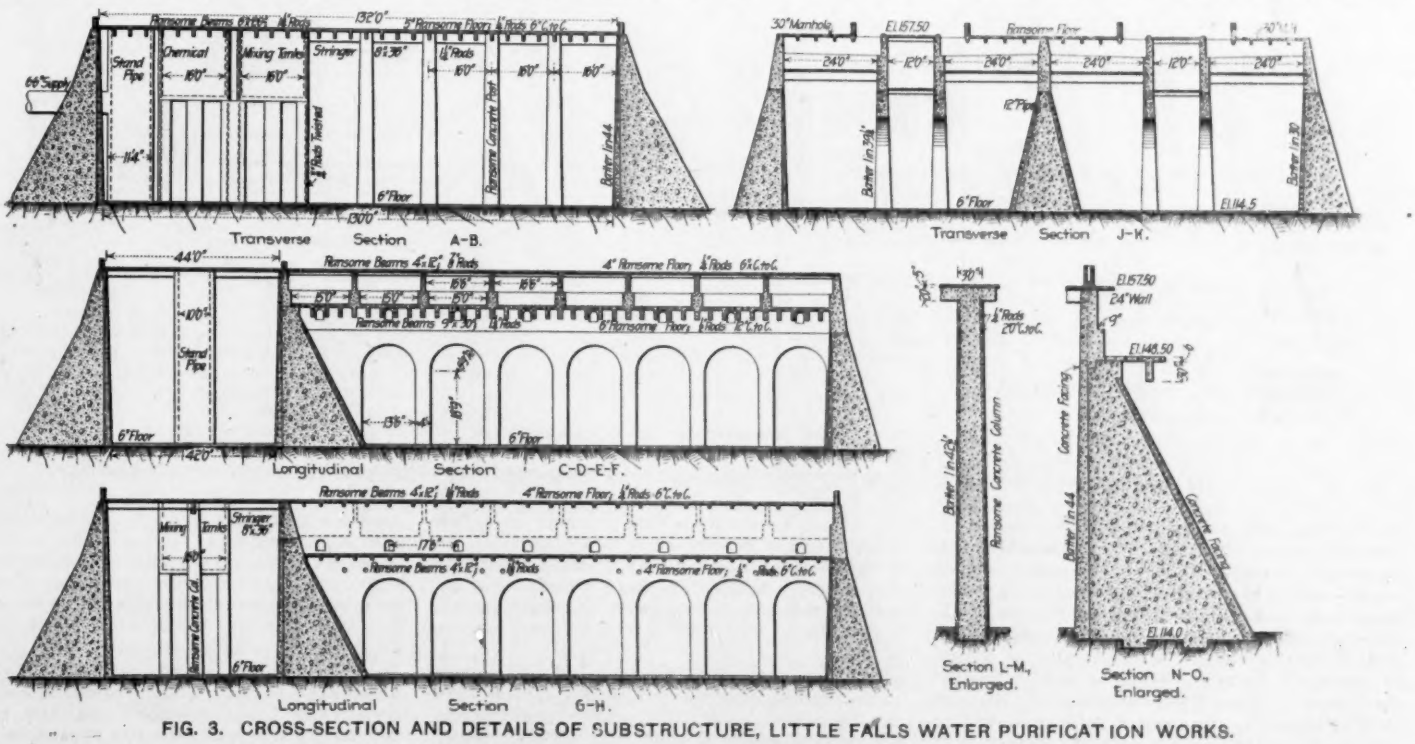


FIG. 3. CROSS-SECTION AND DETAILS OF SUBSTRUCTURE, LITTLE FALLS WATER PURIFICATION WORKS.

(3) Thirty-two rectangular masonry filters (Fig. 5), each 24 × 15 ft., arranged in four rows of eight

(5) Filter houses and covers, consisting of two ells to the main building over the coagulating basin, each about 30 ft. wide, and extending over the operating platforms and about 6 ft. to either side, as shown in Fig. 5. Over the portion of the filters not covered by these buildings is a masonry

wood is used about the buildings except for doors and windows.

It is to be noted that the basins are unusually deep, due to the relative elevation of the water in the head race canal and the rock surface at the site of the plant. Considerable grading is also re-

*The Continental Filter Co. and the New York Filter Co. are now consolidated under the name given. At the date mentioned, and until quite recently, Mr. Parmelee acted as consulting expert for the Continental Co.—Ed.)

quired in order to secure suitable approaches for driveways.

It is proposed to use sulphate of alumina as a coagulant. During periods of exceedingly heavy freshets it may be necessary to add a little alkali to the water, and provisions are made for the addition of soda. Sulphate of alumina solutions will ordinarily be prepared, having a strength of 3%. The two mixing tanks are made of concrete, and placed beneath the floor over the coagulating basin. Their capacity is about 48,000 gallons. This solution will be elevated from the mixing tanks, used alternately, to a discharge tank in which the solution will be held at a constant level. It is proposed to pump an excess of solution to the tanks, having the surplus return through an overflow pipe back to the mixing tank. The pumps are to be operated by electric motors. From the discharge tank the solution will flow by gravity into the main influent pipe leading to the coagulating basin. The rate of application of this solution will be controlled by standard orifices, through which the sclution will flow under a constant head. A series of phospo-bronze orifice plates will be provided, each plate containing 32 orifices, corresponding to the number of filters. In operation, as many of these orifices will be plugged as there are filters out of service. In each plate of the series the sizes of the orifices will be such as to provide a fixed rate of application of sulphate of alumina to the water treated, the series of plates covering the full range in amounts to be used for the differences in character of the river water. This method of regulation is made possible by the use of automatic controllers to maintain a constant rate of delivery by each filter.

The piping from the discharge tank will connect with a pipe manifold placed in the 66-in. influent pipe near its mouth. This manifold, arranged as a lattice, will have a series of orifices spaced about 6 ins. apart, to insure a thorough distribution of the coagulant in the water. The influent pipe connects with a 10-ft. circular stand-pipe about 18 ft. from the top of the latter, as shown in Fig. 4. Mixing of the water and coagulant will be facilitated by the incoming stream striking the wall of this stand-pipe.

Normally the treated river water will pass through gates at the bottom of the stand-pipe into the coagulating basin, to be collected at the opposite end of the basin near the top, whence it will flow through the 48-in. pipes leading to the filters. Arrangements are also provided for by-passing the coagulating basin, under which condition the gates at the bottom of the inlet stand-pipe would be closed, and the treated water pass from the stand-pipe near the top into a piping connection with the filter influent pipes in the galleries.

The rectangular filter tank is made possible by the use of air agitation in place of mechanical agitation. A blowing engine, with motor attachment, is provided to deliver air under a pressure of about 5 lbs.

The size of the single filter unit, 360 sq. ft., having a normal capacity of 1,000,000 gallons daily, was based upon considerations with regard to supplying wash water satisfactorily. To assist in the removal of the dirty wash water, a central overflow gutter is provided, in addition to those at the sides of the tanks.

The filters, shown by Fig. 5, are to be provided with Continental strainers, over which will be placed 6 ins. of fine screened gravel and 30 ins. of medium sand. The sand is to have an effective size within the limits of 0.35 to 0.42 mm.; and not more than 1% by weight is to be finer than 0.25 mm., and not more than 0.2% finer than 0.20 mm. There will be about 3 ft. in depth of water above the sand. The total available head from the water surface to the automatic controllers resting upon the floor of the pipe gallery is to be about 10

Three sets of orifice rings will be provided for each controller, so that the daily yield for each filter may be 1, 1.25, or 1.5 million gallons. Normally the filtered water will flow directly from the several controllers into the clear water basin below. The piping will be so arranged, however, that all of the filters can discharge into either compartment of the basin, as desired.

All valves on the filters are to be provided with hydraulic cylinders for opening and closing. Upon the platform above the pipe galleries, opposite each filter, there will be provided an operating

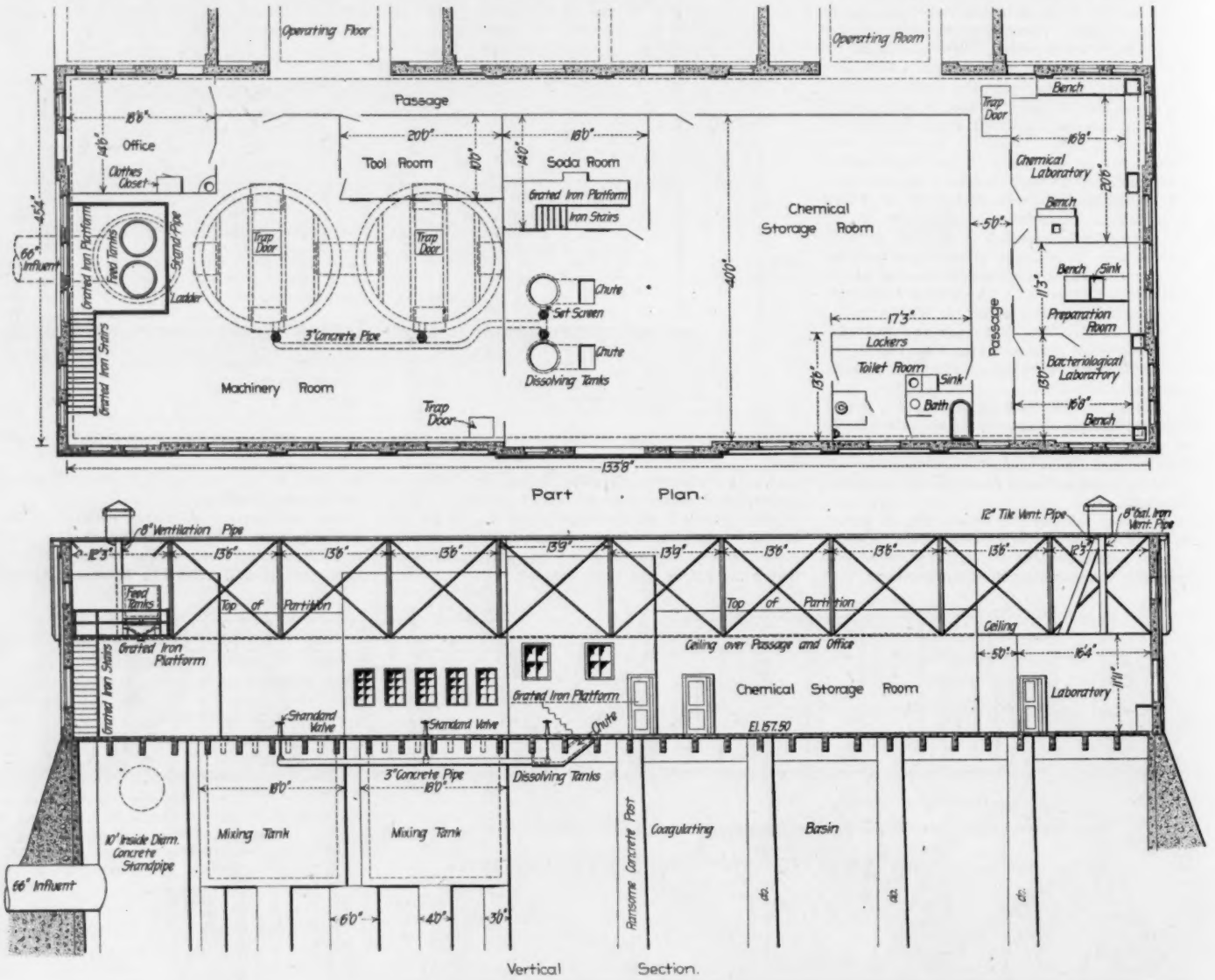


FIG. 4. PLAN AND SECTION OF HOUSE OVER COAGULATING BASIN, LITTLE FALLS WATER PURIFICATION PLANT.

The work was let in two contracts. Contract A, awarded to the T. A. Gillespie Co., of 39 Cortlandt St., New York city, includes in general terms all excavation, masonry, buildings, outside piping and those inside pipes laid in the walls. Contract B, awarded to the New York Continental Jewell Filtration Co., 15 Broad St., New York city, includes, roughly speaking, all chemical appliances and filter devices and appurtenances exclusive of the filter tanks.

(We desire to call attention to a few details of construction not mentioned by Mr. Fuller, but shown by the illustrations. The well holes shown by dotted lines in the outer walls of the substruc-

ture, Fig. 2, are to be left open for a time to guard against cracking, in accordance with the common practice in heavy concrete work. Details of the heavy Ransome concrete and steel rod floor system beneath the filters, and the posts down the center line of the coagulating basin, are shown by Fig. 3. The convenient arrangement of laboratories, water-closets, and baths, is shown by Fig. 4. Further details of the filters and piping are postponed on account of possible changes during construction.—Ed.).

IS THERE A PLACE FOR A PROFESSION IN COMMERCE?*

By Henry Smith Pritchett, Ph. D., LL. D.†

Modern industrial progress in America concerns itself with many factors, but there are three which are distinctly characteristic of modern industrial life. They are, first, the ease of communication and of transportation; secondly, the influence of the trained engineer and the effect of his training upon the mechanic; and, lastly, the tendency in all directions to concentration and organization.

It would scarcely be denied, I think, that the first of these factors is that which most distinguishes modern conditions of commerce from those of a hundred years ago. The man of commerce to-day may command the information of the whole world hour by hour, and may act from that information with as great certainty as the local merchant could act a hundred years ago with regard to trade in his own town. Nothing is more startling, nothing more far-reaching in its consequences, than this marvellous improvement in inter-communication. It makes possible enterprises conceived in the brain of one man and carried out simultaneously over the whole world.

A second feature which seems to me also most important and most characteristic, at least, of all American progress in commerce and manufacture, has to do with the extraordinary efficiency which has resulted in the United States from the co-operation of the trained engineer with the trained mechanic. It is little more than a generation ago since men believed that an engineer could not be taught in the schools; an engineer, it was said, must learn his trade, it was then scarcely a profession, by the practice with other engineers. By and by there came a belief that there was a groundwork which might be learned in a few years in a school, which would require years to learn by practice, and which in many cases never could be learned. The result of this training bore fruit in the rise of a generation of engineers. The training of the engineers who have graduated from the technical schools forms only a small part of the work which these schools have indirectly done. Each engineer who has charge of men has become himself an instructor of the mechanic and of the laborer below him; and it is this combination which has been the basis of our industrial efficiency.

The third feature of modern industrial life to which I allude is the tendency to organization and concentration. This tendency is evident in all directions, whether one considers the enterprises of capital or the brotherhoods of labor. Almost all social organizations show in these days a tendency to combine.

Let me now try to point out the manner in which these conditions concern the education of the man of commerce and the man of administrative work. It has been a noticeable feature of the progress of the last generation that the engineer and the superintendent receive their training in the schools; whereas those who undertake to dispose of the manufactured product, who organize the enterprises of commerce, who direct industries, and who have to do with manufacturing and trade in their widest directions—of these men it is said, as it was said forty years ago of the engineer, that they must learn their business by experience; that there is no groundwork of knowledge to which they may be pointed in the schools, and which would not save time for them, but which would also develop for such places men of wider vision and stronger character, and of greater resources. I shall try and point out why in my judgment the conditions to which I have alluded make necessary such a training.

The relation of the quickness of intercommunication to the duties required of the administrative man in commerce are evident at a glance. The man who would take part intelligently in the commerce of to-day must know not only the conditions in his own country, but also the conditions in other parts of the world; or he must at least know how to go to work intelligently to find out those conditions. In other words, the man of commerce of to-day is concerned rather with world conditions than local conditions.

The significance of the second fact to which I have called your attention, that of the relation of the trained engineer to the mechanic and the laborer, is found in the fact that it enables higher paid labor and well paid skill to compete successfully with poorer paid and less skillful service.

The significance of the third fact to which I have alluded, namely, the tendency to concentration, is too constant a topic of discussion in the daily press to escape daily attention. Combinations of capital of some sort are likely to continue so long as they are formed inside the law and so long as they serve real purposes; and the right of men to combine in such industrial enterprises to promote efficiency and to cheapen production seems to me clear. It seems to me, further, that the spectacle of a trust buying up factories wholesale, while not without food for thought, is not so terrifying as many would have us believe. I have been told that if we took into account the number of scrap-heaps which have been sold to the trusts under the name of factories, one now and then might squeeze out a tear of sympathy for the syndicates themselves.

In the same way the right of men to organize to protect labor and to secure for themselves rights and even privileges is equally clear. It is practically certain, to my thinking, that both of these forms of combination have come to stay, in a more or less modified form. The difficulties which have beset both classes of combination and which have brought forth from both merited criticism, is the fact that men have desired this power and have undertaken to wield it while refusing to assume the responsibility which such power must carry with it. It may be assumed as certain that if such concentration of power is to be made, whether in the hands of one sort of men or another, society will demand, and this demand will be enforced, that such quasi-public assumption of power shall be held in due regard of the responsibilities which go with it.

Selfishness and avarice are no more the property of one class of men than are truth and honesty. We smile at the lack of judgment which puts forward the walking delegate as the representative of honest workmen, and yet it is well matched by the simplicity which assumes that monthly visits to a factory by a New York stockholder will take the place of intelligent local supervision. The representatives of more than one syndicate have been able to point out most intelligently the short-sightedness which arrays capital against labor, and yet these same men have replaced skilled engineers with the sons of directors, and then have mildly wondered why the reputation of their product fell away, why their employees were discontented, and why dividends were no longer possible. My impression is that the trusts cannot be wholly bad because they give so many evidences of the possession of one of the sweetest of human virtues, that of simple, childlike faith.

To come back, however, to the real matter in hand, I wish to call your attention to the fact that those who are called upon to administer under the conditions of modern industrial life must be in a position to understand and to deal with this question from both sides, and that this ability requires not only breadth of vision, openness of outlook and fairness of mind, but that still rarer quality, the ability to understand the other man's point of view.

In the changed conditions of to-day, a man ought to be educated in some broad view of the relation of men to each other, if he is to assume administrative duties in commercial affairs of large magnitude.

To bring together, therefore, the conclusion of my whole argument, the conditions of modern life are such, the facilities of communication are so great and play such a part in success, the relations of men are so complex and upon so large a scale, that the time is near when those who are to direct great organizations, who are to control and develop manufactures, who are to trade between nations—in a word, the Captains of Commerce—must look upon their calling as a profession, not as a business; and for this profession there is a training to be had in the schools which will not only save time for the individual, but which will develop a broader, a more efficient and a higher type of man; a training which shall bring not only a keener vision but a wider outlook and a better perspective.

Doubtless such courses of study as might be inaugurated at this time would be in large measure tentative, as they were in the case of the engineer. That efforts already made in starting schools of economics do not meet the case is evident from the fact that the few who attend these schools afterward go into this vocation and not into commerce. The same was true of the courses of study first offered to the engineer. But in this gradual adaptation of a training to the needs of certain professions there has resulted not only the evolution of a course of study, but also the uplifting of a whole circle of professions. I can but believe that similar facilities offered to students of commerce and of commercial relations would result, likewise, not only in finding a training fitted to their need, but also that it would result in bringing in a higher ideal of the work and of the responsibility of the man of affairs.

*Extracts from an address delivered before the New England Cotton Manufacturers' Association.
†President Massachusetts Institute of Technology.

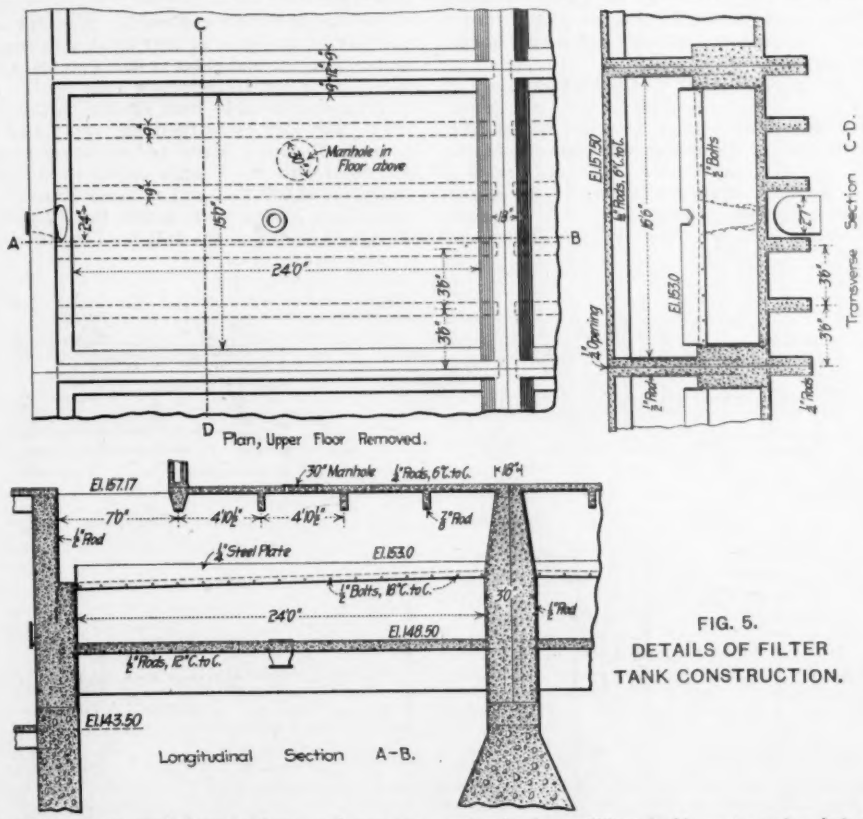


FIG. 5.
DETAILS OF FILTER TANK CONSTRUCTION.

66-FT. RAIL CARS AND 38-FT. GONDOLA CARS.

(With two-page plate.)

In shipping rails, the ordinary 30-ft. rails are usually carried in stock, gondola, or flat cars having a length of somewhat over 30 ft. The 33-ft. rails now in use on several roads may also be carried in this way, but the 45-ft. and 60-ft. rails are generally loaded on two or more flat cars, the methods of loading and fastening being prescribed by the rules of the Master Car Builders' Association. A notable exception to the ordinary practice of loading long rails is that of the Lorain Steel Co., of Lorain, O., a large proportion of the product of its works being 60-ft. girder rails for street railway track. For transporting these rails with a minimum liability of injury special gondola cars, 63 ft. 4 ins. long inside, have been built, and have now been in service for nearly two years. The Cleveland, Lorain & Wheeling Ry. is using 38-ft. gondola cars for carrying long rails, each car having a movable gate at one end, so that they can be used in pairs for carrying rails, etc., or as

ordinary cars for coal, ore, etc. The dimensions of these cars are as follows:

	Kind of car—Rail.	Gondola.
Length over end sills	66 ft. 4 ins.	38 ft. 0 ins.
Length inside	63 " 4 "	36 " 4¼"
Width over side sills	8 " 11 "	8 " 6 "
" over sides	9 " 8 "	9 " 8½"
" inside	8 " 3 "	9 " 4 "
Height inside	2 " 0 "	3 " 6 "
Height of top from rail	6 " 2 "	7 " 8 "
Wheelbase, truck	5 " 2 "	5 " 2 "
Distance c. to c. of trucks	53 " 8 "	26 " 8 "
Weight	38,700 lbs.	32,700 lbs.
Capacity	80,000 "	80,000 "

In transporting rails on the Cleveland, Lorain & Wheeling Ry., 30 and 33-ft. rails are usually loaded in gondola cars, or if loaded on flat cars temporary end gates are provided to prevent the loads from shifting. Rails 60 to 65 ft. in length are usually loaded on two flat cars or on two gondolas with the inner ends removed, the rails resting on bolsters just behind the end trucks, while smaller bolsters are placed over the body bolsters of the inner trucks to prevent undue sagging and swaying of the load. On flat cars, the rails are clamped together by uprights and cross timbers and inclined struts at the main bolsters, and at the middle by side timbers with top and bottom rods. Rails 45 and 50 ft. long are loaded in two groups on three flat cars, the main part of each group being carried by the end cars, while the middle one supports the projecting ends of both groups. The introduction of the inner bearings on double loads was inaugurated at the Lorain Steel Works, and embodied in the M. C. B. rules three or four years ago. A center clamp has since been added, which is very essential, as in the event of the end clamp failing, the center clamp will retain the load in a compact position, and make it safe to haul the car to some point where the repairs can be made to the load. This road is loading to the full marked capacity of cars when loaded in twin loads, and 75% of the marked capacity of all three cars when loaded in triple loads. For handling long rails, the Lorain Steel Co. is equipped with automatic hoists, and the rails are all loaded onto the cars by means of these devices, thus overcoming the possibility of damage to cars by allowing the rails to fall from skids onto the car floor.

66-FT. RAIL CARS.

These long cars for carrying rails are shown in Fig. 1, and the most important feature of their construction is the system of trussing to prevent the sagging of the long shallow body. The floor of the car is set about 4 ft. above the rails. The floor framing consists of eight longitudinal sills, with four transverse needle beams. The side sills are 5 × 14 ins.; the center sills, 4½ × 8 ins.; and the intermediate sills, 4 × 8 ins. These are all fitted to the end sills (12 × 10½ ins.), by means of malleable iron pockets, thus ensuring an end bearing of the full area of each side sill. To stiffen this floor system there are first eight 1¼-in. truss rods (A) arranged in the usual way, passing through the end sills (the middle rods also serving to secure the dead blocks), over the bolsters, and under struts attached to the needle beams. In this car, however, there are four sets of these struts, 11 ft. apart, or 33 ft. apart over the outer struts. The four inner truss rods pass under all these struts. The four outer rods are carried horizontally beyond the bolsters to a point over the outer needle beams, and then descend to pass under the middle pair of struts. Besides these there are four outside truss rods (B) (one on each side of each sill) which extend up the sides of the car to stirrups seated on the top. These rods pass through the end planks, continue horizontally to the stirrups, which are directly over the bolster, and then descend to the outer set of struts. All this trussing is from the ends. At the middle of the car, however, two rods (C) on each side are carried by stirrups near the top of the side, and extend downward below the sills, the washer plates on the ends of the rods bearing against wooden struts which are butted against the needle beams. All rods are 1¼-ins. diameter. A steel plate ¾ × 10 ins. on the face of each end sill furnishes an anchorage for the eight truss rods (A), while each pair of rods (B) and (C) has a heavy washer plate.

The ends and sides are of 4-in. planks, supported by side stakes in the ordinary way. Through the side sills are passed ¾-in. tie-rods. The floor is of 3-in. planks. The body bolsters are of steel, of the Bettendorf pattern, made specially deep. Inside the car, over the bolsters, are two transverse timbers 6 × 8 ins. with ⅞-in. through tie-rods, and having 5-16-in. steel plates on top. These form the supports for the rails, and carry them above the camber in the center of the floor. When the cars are loaded with short material, it must be equally distributed for a distance of 18 ft. from each end. The cars are mounted on diamond trucks, as noted below, and fitted with Westinghouse air brakes, M. C. B. pocket couplers, and the National hollow brakebeam. Hand wheels for the brakes are fitted at each end. Malleable iron castings are used throughout, except for drawbar stops and floor cup washers.

The draft gear is fitted between draft timbers under the center sills, and extending back to the bolsters, to which they are secured by strap bolts, as shown in Fig. 2. Under each draft timber, also is a bar or strap ⅝ × 4 ins., through which the draft bolts pass. The coupler is maintained in its normal position in the center line of the car by means of two centering springs, set on either side of the drawbar, as shown, and fitted to pockets let into the draft timber. Subsills 4½ × 5 ins. extend between the ends of the draft timbers, under the center sills. Subsills 3 × 5 ins. and 5 × 5 ins. are fitted between the bolsters and needle beams, under the side sills.

In construction, the car is cambered as shown by the dotted line in the longitudinal section. Starting at each end immediately over the body bolster, the lower edge of the bottom side plank is cut to a curved line for the camber. The car frame is trussed up to a camber of 5 ins. at the center, while the sides are trussed up 2 ins., the lower plank having been cut away for 3 ins. After several months, the deflection seldom reaches 2 ins. under full load. For carrying coke, 50 of these cars were temporarily fitted with coke racks which enabled them to be loaded to their full capacity.

The cars are owned by the Lake Terminal R. R., which is the name under which the Lorain Steel Co.'s industrial lines are operated. They were designed by Mr. F. H. Stark, Master Car Builder of the Cleveland, Lorain & Wheeling Ry. About 100 of these cars are now in service.

38-FT. GONDOLA CARS.

The 80,000-lb. 38-ft. freight cars of the Cleveland, Lorain & Wheeling Ry. are of substantial design, intended for heavy service, and the malleable cast-iron fittings used are mostly of the same design as those on the 66-ft. cars above described. As shown by Fig. 3, the floor framing consists of eight longitudinal sills, with end sills and needle beams, trussed by eight rods 1⅛ ins. diameter, with 1⅝-in. upset ends. All these rods pass through the end sills. The side sills are 5 × 12 ins.; center sills, 4½ × 8 ins.; intermediate sills, 4 × 8 ins.; end sills, 7 × 12 ins.; center subsills, 4½ × 5 ins. The truss-rod struts are inclined, as are also the needle beams, as shown by the longitudinal sections. The floor planks are 2¼ × [illegible] ins., with rabbeted edges. The side planks are [illegible] × 10½ ins., and are placed outside the stakes, to which they are secured by ½-in. button-headed bolts. The heads are on the inside, and the nuts screw down upon iron straps ¼ × 2½ × 42 ins., outside the planking. The stake pockets are held by U-bolts in the usual way.

One end of the car is fixed, and is similar to the side construction, the corners being heavily strapped. At this end is placed the hand-wheel for the brakes. At the opposite end of the car is a portable end gate. The body bolster is of the railway company's standard pattern, having a horizontal top plate and lower arch bar, the latter passing under the draft timbers. It is exceptionally deep, 10⅞ ins., and two patterns, with steel filler and malleable spring sleeves, are shown in more detail in Fig. 4. The draft rigging is very similar to that shown in Fig. 2, there being draft timbers below the center sills, with subsills 4½ × 5 ins., extending between the ends of these timbers. The bolster connections and drawbar centering springs are not used, however, as in the other car.

Permanent safety chains are provided at the end having the gate, so that two cars coupled together with the end gates or doors removed can be safely used for transporting long rails, which form a considerable item of the traffic of this road. The cars carry their full rated load as an average, including slack and all other grades of soft coal; with run-of-mine or lump coal they are loaded to 88,000 lbs., and in some cases the cars have been loaded with 91,000 lbs. of soft coal. They are loaded to the full limit on their initial trips, and no cut journals or hot boxes have resulted. The company has 800 of these cars in service, and 500 more are under construction.

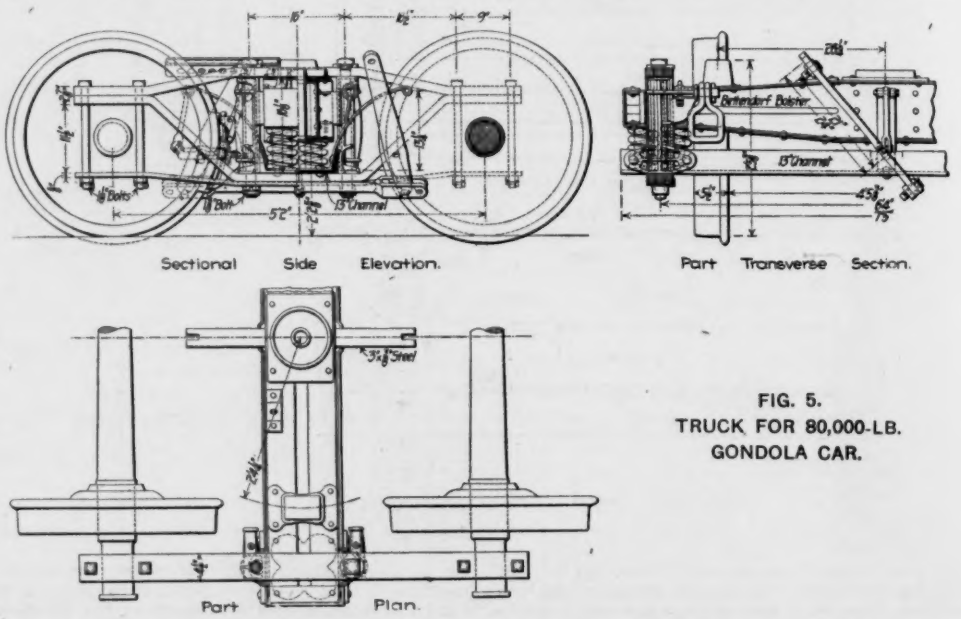


FIG. 5.
TRUCK FOR 80,000-LB. GONDOLA CAR.

TRUCKS.

Both the cars above described have trucks of the arch-bar or diamond-frame type, but while the 66-ft. rail car has the Common-Sense truck bolster, the 38-ft. gondola car has the Bettendorf truck bolster. The details of the standard truck, fitted with the latter bolster are shown in Fig. 5. The upper arch bar is 1½ × 4½ ins.; lower arch bar, 1⅜ × 4½ ins.; tie-bar ⅝ × 4½ ins. The upper arch bar is cambered 3⅛ ins., and in former designs its ends butted against lips on the lower bar. In the latest standard, however, this feature has been eliminated. The clear distance between the bars at the center is 16⅛ ins. The column bolts are 1⅝ ins. diameter, and between the column castings is the spring plank, formed of a 13-in., 42-lb. channel laid with the flanges upward. Under each end of the bolster are four 8-in. coiled springs.